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Innovations in e-Business:
Can Government Contracting be Adapted to Use Crowdsourcing and Open Innovation?

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September 2010

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This report investigates the scope and boundaries surrounding Open Innovation methodologies, Web 2.0 technologies and Crowdsourcing to determine their appropriateness for government use and how/when they can be used. Open Innovation methodology revolutionizes the inflow and outflow of organizational information and the administration of intellectual property. It brings together individuals with diverse talents across multiple disciplines to collaborate on projects. Web 2.0 technologies include Wikis, blogs, video-sharing and social-networking sites, used for more efficient communication and knowledge sharing. Crowdsourcing is an online collaborative decision-making effort that reaches thousands of people at one time, who deliver bits and pieces of information, which are compiled into an innovative product or service. This process captures talent from research institutes, universities, non-profit organizations, small businesses, consultants, inventors and others to produce solutions to tasks, pioneer new technologies, or capture, systematize, and examine large amounts of data. Commercial businesses are using these technologies and methodologies to successfully bring new products to market, improve their existing products and improve customer service. The government may benefit in a similar manner.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARPANET	Advanced Research Projects Agency Network
ACI	American Competitiveness Initiative
ADA	Anti-Deficiency Act
BAA	Broad Agency Announcement
C4ISR	Command, Control, Communications and Computers, Intelligence, Surveillance and Reconnaissance
CAMBIA	Center for the Application of Molecular Biology to International Agriculture
CBRN	Chemical, Biological, Radiological, and Nuclear
CCA	Clinger-Cohen Act
CDC	Center for Disease Control and Prevention
CIO	Chief Information Officers
CLP	Continuous Learning Point
CRADA	Cooperative Research and Development Agreements
CREATE	Cooperative Research and Technology Enhancement
CRS	Congressional Research Service
CTO	Chief Technology Officer
DARPA	Defense Advanced Research Projects Agency
DAU	Defense Acquisition University
DFAR	Defense Federal Acquisition Regulation
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instructions
DOE	Department of Energy
DOT	Department of Transportation
DPAP	Procurement, Acquisition Policy, and Strategic Sourcing
EA	Evolutionary Acquisition
EBI	European Bioinformatics Institute
FAR	Federal Acquisition Regulation
FASA	Federal Acquisition Streamlining Act
FTTA	Federal Technology Transfer Act
GAO	General Accountability Office

GDP	Gross Domestic Product
GDSS	Group Decision Support System
GOGO	Government Owned Government Operated
GPS	Global Positioning System
HBR	Harvard Business Review
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HTTP	Hyper Text Transfer Protocol
HUD	Housing and Urban Development
IBM	International Business Machine
IED	Improvised Explosive Device
IEEE	Institute for Electrical and Electronic Engineering
IP	Intellectual Property
IT	Information Technology
ITC	International Telecommunications Union
JPEO-CBD	Joint Program Executive Office for Chemical and Biological Defense
LAN	Local Area Network
LSG	Life Science Grid
MAN	Metropolitan Area Network
MIT	Massachusetts Institute of Technology
MPEG	Moving Pictures Expert Group
NASA	National Aeronautics and Space Agency
NCRA	National Cooperative Research Act
NSC	National Security Cutter
NSF	National Science Foundation
NCRPA	National Cooperative Research and Production Act
OEM	Original Equipment Manufacturer
OGI	Open Government and Innovations
OI	Open Innovation
OIF	Operation Iraqi Freedom
OMB	Office of Management and Budget
ORTA	Office of Research and Technology (USJFCOM)
OSD	Office of the Secretary of Defense
P&G	Proctor and Gamble
PGI	DFAR Procedures, Guidance and Information

PPBS	Planning, Programming and Budgeting System
R&D	Research and Development
RIAA	Recording Industry Association of America
RSS	Really Simple Syndication
SBIR	Small Business Innovative Research Program
SNP	Single-Nucleotide Polymorphism
SOP	Standard Operating Procedure
SSO	Standard Setting Organization
STTR	Small Business Technology Transfer Program
USB	Universal Serial Bus
USDA	Department of Agriculture
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
USJFCOM	United States Joint Forces Command
USPTO	United States Patent and Trademark Office
WAN	Wide Area Network

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EXECUTIVE SUMMARY

The general public has embraced a new generation of Internet technologies for their personal enjoyment. Examples of such technologies are communication tools such as blogs and Twitter, knowledge databases like Wikipedia, video-sharing sites such as YouTube and social networking Web sites like MySpace and Facebook. Collectively, these and other Internet-based technologies are known as Web 2.0 tools or applications. Commercial and non-profit organizations at the forefront of their industry are leveraging new Internet-based technologies to broaden and enhance communication between relevant individuals within and outside their organization. They do this by giving their employees the freedom to exchange ideas in order to build a network of business partners. In this fashion, organizations get access to and share specialized knowledge to solve management or operating problems and/or to collectively collaborate in temporary or virtual teams to create new products. Presently, the most well known and successful collaborations have been software products, such as the Linux operating system. Further, it is this report's opinion that the same infrastructure used to produce Linux can be appropriated by the government to solve highly complex problems at lower cost and in the most expedited manner.

Innovative business models, such as Open Innovation, promote organizations to solicit and share information and expertise outside of their organization in the normal course of business, thereby accelerating innovation in the private sector and academia. Crowdsourcing, another new business concept, combines Web 2.0 technologies and Open Innovation methodologies to connect individuals with diverse areas of expertise from multiple disciplines via the Internet in order for them to collaborate on innovative projects. This process can capture talent from small businesses, professional consultants, researchers, inventors and even amateurs to produce solutions to specific tasks, pioneer new technologies, improve an algorithm, or capture, systemize and analyze large volumes of data. The question this project poses, however, is whether these technologies and methods can be used by the government and in which ways can they potentially improve and add value to the Department of Defense (DoD) acquisition and contracting processes.

In addition, this project explores possible limitations and constraints that the government might face in implementing these business practices.

A thorough literature review explains the relevant concepts and technologies, such as Open Innovation, Web 2.0 technologies and Crowdsourcing. The existing federal acts governing the legal framework of Internet-based and collaborative projects and current sources of DoD funding for R&D are also reviewed. Pertinent examples highlight how these concepts and technologies are applied in the commercial world. Next, examples of potential future DoD applications of Open Innovation, Web 2.0 technologies and Crowdsourcing are discussed. A thorough analysis of the benefits, limitations and problems associated with these new concepts and technologies is followed by practical solutions. Conclusions and practical recommendations summarize the findings in this report.

Although these concepts and technologies have demonstrated significant advantages and benefits over traditional approaches, and have established a track record of success in the private and non-profit sectors of the economy, the government—and the DoD in particular—has not embraced them so far. However, DoD acquisition teams, including Contracting, need better tools and methods to improve their performance and enhance their creativity.

While Open Innovation, Web 2.0 technologies or Crowdsourcing techniques are not specifically addressed in the existing legal framework, the Clinger-Cohen Act does provide authorization for government agencies to reform acquisition laws and information technology management. In addition, the E-Government Act mandates Agencies to improve management practices and supports the promotion of electronic government services and processes. Furthermore, the Bayh-Dole Act and its amendments ensure that inventions made in collaboration between the federal government and nonprofit organizations, including universities, can be patented and commercialized by the research institution. However, the *Antideficiency Act* (ADA) prohibits federal agencies from spending or promising to spend any funds before Congress explicitly authorizes or apportions monies for a specific purpose. Since Crowdsourcing often relies on customers,

suppliers, competitors and other unpaid volunteers to contribute and share their knowledge and expertise with large collective, contributors have to understand that there is no reimbursement for their efforts.

However, there are limitations to using these technologies. Training and motivating personnel who are not already familiar and comfortable with these novel approaches and Internet technologies remains a challenge. Data mining blogs and enormous databases for useful information and monitoring the accuracy of their content require sophisticated algorithms specific to government uses. The participation of a great number of individuals in problem solving for government programs creates concerns about potential security breaches. Adoption of these novel approaches also challenges the established culture and organizational structure within the government; therefore, upper level management support is crucial to establishing and running a successful program.

In order to implement Web 2.0, Open Innovation and Crowdsourcing within the government and DoD, it is important to carefully benchmark successful commercial projects to learn what drives success and to avoid pitfalls. It is essential to start with small incremental steps; that is, establish an interactive and cross-linked Wiki-style database to access policy, procedures, regulations, reports and training, and build acceptance and experience from there. Careful selection and design of pilot programs allow government officials to determine best practices and develop expertise.

Based on research of relevant subject literature, social networking and corporate Web sites, federal acts and General Accountability Office (GAO) and DoD reports, the following conclusions are drawn: Crowdsourcing and related technologies and approaches have a proven track record of success in diverse applications in the private and non-profit sector. Open Innovation can speed product development, reduce cost and increase end-user satisfaction, which are key objectives for the DoD. These approaches can generate savings from increasing efficiencies in knowledge management, by pooling of expertise and through interagency collaboration. Open Innovation and Crowdsourcing accelerate the dissemination of innovation and knowledge, which promotes the commercialization of spin off technologies. For Crowdsourcing to realize its full potential participants have to be selected with care and their group dynamics have to be monitored

and managed. Evaluating and implementing these novel tactics is of strategic importance to the U.S. government, in order to maintain a competitive edge in military development.

The following recommendations were made for the implementation of Crowdsourcing, Open Innovation and Web 2.0 into government practices:

- Benchmark the best commercial practices
- Conduct a cost-benefit analysis
- Address security concerns
- Research and establish a legal framework
- Conduct research into motivating Crowdsourcing participants
- Conduct research into optimizing participant selection

I. INTRODUCTION AND METHODOLOGY

In 1995, Vice President Gore supervised the government's acquisition reform. This brought about the Federal Acquisition Streamlining Act (FASA), which was intended to simplify the way the government does business and to align the acquisition process with common practices in private industry. However, since then, the Federal Acquisition Regulation (FAR) and Department of Defense (DoD) and Army procurement guidance have changed continuously and sometimes dramatically. Over the last 15 years, the FAR has been subject to 147 revisions, some of them major changes of the regulations. Moreover, the 2009 version of the Defense Federal Acquisition Regulations (DFAR) has 305 more pages than the 2001 version. Additionally, the DFAR Procedures, Guidance and Information (PGI) and local agency regulations have also grown since that period. However, the number and scope of these changes have been impossible to quantify. Changes instituted by the FASA to streamline contracting practices and give Contracting Officers more discretion have multiplied the number of regulations, documents and authorizations and now tax the resources and expertise of many Contracting Officers.

Further, changes in the FAR and DFAR potentially complicate the acquisition process by lengthening the time span acquisition teams take from defining a need or requirement to placing a contract with a vendor. In addition, the acquisition process becomes progressively more time consuming when acquisition teams are asked to find a commercial solution to a current problem to satisfy complex regulations.

Acquisition teams, including Contracting, need better tools and methods to improve their performance and effectiveness and enhance their creativity. This project analyzes how Web-based technologies can improve the efficiency as well as the effectiveness of the acquisition process. This project will determine if a new Web-based collaboration, called "Crowdsourcing," can benefit the DoD by:

- Innovating the R&D process,
- Reducing the cost of system acquisition,

- Creating databases or knowledge centers to store institutional knowledge
- And improving customer service.

In addition, this project explores possible limitations and constraints the government might face in implementing these new business practices.

Crowdsourcing applies two business strategies, "Open Source" and "Open Innovation," which are central to innovating and modularizing system design to improve the efficiency and effectiveness of the development process. The concepts "Open Source" and "Open Innovation" will be discussed further in the literature review. Additionally, Crowdsourcing makes extensive use of Internet-based Web 2.0 tools and applications that could allow acquisition teams to tap the knowledge of diverse sources such as other work teams, colleagues outside of their agency, academic experts, contractors and independent outside experts better and faster than possible today.

Based on successful commercial applications such as Linux, Wikipedia and Proctor and Gamble's Connect and Develop program, the government and, in particular, the DoD, may potentially realize the following benefits by adopting Open Innovation concepts, Crowdsourcing methodologies and Web 2.0 technologies:

- Web 2.0 can improve knowledge management by organizing policies, regulations, procedures and best practices in one Wiki style database that cross links related topics and is easier and more efficient for Acquisition Professionals to search, update and maintain.

- Crowdsourcing strategies can potentially save government funds in the pre- and post-contract phase by sourcing a greater number of commercial off-the-shelf items, by streamlining the market research process for Acquisition Professionals and by stimulating transfer and spin off technologies from government programs.

- Crowdsourcing, Open Innovation and Web 2.0 technologies may facilitate interagency collaboration by sharing research findings across agencies, eliminating duplication and redundancies in R&D and proactively pooling resources for basic research.

These new business methods and technologies have the potential to optimize the way the government, the DoD and its Acquisition Teams organize and manage collective knowledge and how these entities search for and share information, such as directives,

memorandums, regulations and even best practices across linked interactive databases. All these important concepts and technologies will be discussed within the scope of this report.

A thorough literature review explains the relevant concepts and technologies such as Open Innovation, Web 2.0 technologies and Crowdsourcing. Furthermore, this research project reviews the existing federal acts governing the legal framework of Internet-based and collaborative projects and the current sources of DoD R&D funding. Pertinent examples highlight how these concepts and technologies are applied in the commercial world. Next, examples of potential future DoD applications of Open Innovation, Web 2.0 technologies and Crowdsourcing are discussed. A thorough analysis of the benefits, limitations and problems associated with these new concepts and technologies is followed by practical solutions. Conclusions and practical recommendations summarize the findings in this report.

This document is designed to be read in a digital format with Internet access, in order to provide immediate access to relevant sources and to examples of the discussed technologies. In order to demonstrate Wiki technology, the glossary in the Appendix is exclusively sourced from www.wikipedia.com.

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II. BACKGROUND

Private industry traditionally funds research with a specific objective motivated by profit. Because of this profit motivation for research, industry generally stops a research project when the research cannot be profitably commercialized. In the pursuit of innovative ideas, private industry sometimes forms alliances or partnerships with university researchers. The intent of funding a university researcher's work is to purchase ownership of research findings and intellectual property and shield them from public access. Typically, the company will incorporate the research or intellectual property into a marketable commercial product. However, sometimes the company cannot find a way to do this and shelves the research in an archive until an application is determined, funding is secured and / or a market is found. Under unfortunate circumstances, some intellectual property may never get tapped for its commercial potential.

The United States government and its agencies fund basic and applied research and development, either through universities or non-profit organizations or directly through private industry, without aiming for a tangible commercial product or immediate return on investment. The government, for example, funds research into food and nutrition, medical research, social issues, statistical standards and many more public service topics that have no short term-profit potential. It is safe to say that the U.S. government's motivation to sponsor novel research or innovative solutions to problems is not profit driven, and thus differs from private industry. Therefore, the government's willingness to spend on research and development, without an immediate return on investment, is often driven by the anticipation of future (financial and other) benefits to the country, such as a long-term growth in Gross Domestic Product (GDP) or public health and welfare.

Normally, government agencies fund basic research programs through universities and non-profit organizations, using grants. The National Science Foundation (NSF) finances much of the grant-based university research conducted by the government. However, virtually every government agency has in its budget a certain

amount of funding for R&D into their specific area of concern. For instance, the Department of Transportation (DOT) conducts research into highway and rail safety issues, the Department of Housing and Urban Development (HUD) investigates rural housing and economic development and the Department of Agriculture (USDA) and the Department of Energy (DOE) are jointly researching plant genomics of feedstock for future bio-energy.

Researchers and research organizations turn to government agencies or private industry for research funding that exceeds the limited commitment of a grant. Researchers sometimes present unsolicited research proposals to government research agencies for evaluation, hoping to receive a contract. More often, researchers search Broad Agency Announcements (BAA), which are public solicitations for innovative solutions to specific needs that are posted by individual government agencies. Each agency has a selection committee that identifies high-quality proposals and contracts with entrepreneurs, small and large businesses and universities for R&D programs with specific outcomes. However, under these conditions, it is possible for several research organizations to work on similar problems, funded by different government agencies that do not have access to or knowledge of each other's work and results. The problem of redundancy in government research can be lessened by a greater amount of collaboration between agencies.

In the late 1960s and through the 1970s, the U.S. government started funding a Defense Advanced Research Projects Agency (DARPA) project called Advanced Research Projects Agency Network (ARPANET), which required developers to network together thousands of computers in such a way that each one had multiple redundant connections to other computers within the network, with the idea that, even if any one of the links or nodes was severed, the computers on the network could still communicate with each other. This project required computer science researchers from a number of universities to work together writing and developing standards, protocols and software. It eventually depended on international cooperation in order to develop the HTTP standards of early Web pages. In 1983, the government stopped funding the project. However, the

researchers continued their research on their own time, for fun. They formed networks of friends and colleagues and the project continued, eventually developing into the Internet.

The development of the Internet serves as a shining example of how setting a common standard can spur a new industry and economic growth. As recent as the 1990s, companies began to recognize the benefit of collaborating on R&D projects. Some trailblazing corporations such as IEEE, 3Com, DEC, Intel, ATT, Bell Labs and Xerox collaborated on wireless cell phone and wireless home phone standards, local area networks (LAN) and wide area networks (WAN) and Ethernet standards. The incorporation of early standards into consumer products created new markets that did not exist five years prior, and stimulated huge growth in these new industries.

The following examples highlight the logical progression toward Crowdsourcing.

A. USERS AS COLLABORATORS WITH WEB 2.0

Today, a second wave of innovation is driven by collaborative Internet applications rather than solid state electronics. This wave is fueled by recent innovations in Internet technologies that allow Internet users to communicate and collaborate to create and improve online content. Wikipedia is an example of such online collaboration. This online encyclopedia depends on a large number of volunteers who create content and monitor updates and accuracy. In as little as 10 years, Wikipedia has overtaken the *Encyclopedia Britannica* in popularity. Wikipedia is a vivid example of what an organizational knowledge database can look like. Another novel application is social networking services that create online communities of people with common interests. Facebook and MySpace are currently the most well known examples of social networking services. Both provide an interactive, user-friendly Web site that allows users to build content, including personal profiles with photos, music, videos and blogs, and to share them efficiently with an online network of colleagues and friends. Collectively, these new technologies are known as Web 2.0.

B. USERS AS CO-DEVELOPERS OF OPEN SOURCE SOFTWARE

A branch of Internet-based collaborative design is Open Source design, normally associated with the free software movement, and best epitomized by the Linux operating system and the Mozilla Web browser. Open Source is unique because the users become co-developers to the original developer version of the software. After an early release of software, its software code is also released under an Open Source licensing agreement. Co-developers are granted the right to copy, or modify and redistribute the original code and updates, as long as it retains the Open Source licensing agreement. Open Source software is characterized by high modularity or clusters in the design so they are easier to modify by swapping out blocks of software code. Today, Linux is one of the most popular desktop operating systems, but its real niche is with Web and database computer servers.

C. USERS OF OPEN INNOVATION

Open Innovation is another corporate strategy for collaboration via the Internet. During the 1990s, some large established corporations were losing market share and were finding it harder to access new markets. Open Innovation, a term coined by Henry Chesbrough in 2003, calls for an organization to tap new sources for innovation outside of their own research departments. For instance, Proctor and Gamble (P&G) reports that they have 9,000 in-house R&D resources with 1,100 PhDs, but after reorganizing their methods for gathering innovations, they expanded their reach to 1.8 million research scientists, engineers and inventors (Huston & Sakkab, 2006). These researchers and innovators work within P&G's extended network, which was driven by the use of the Internet as a virtual workspace. Many of P&G's outside sources work without direct compensation. Instead, P&G commissions their collaboration and efforts by awarding prize money for the best ideas. P&G retains title to the commissioned intellectual property and sometimes leases it, sells it or gives it away.

D. CROWDSOURCING

The most recent branch of collaborative design spawned by the Internet is Crowdsourcing. Crowdsourcing is a term coined by Jeff Howe in a *Wired* magazine article, written in June 2006, describing how innovative organizations tap large Internet-based groups who voluntarily accomplish a task. Howe describes Crowdsourcing as, "the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call" (Howe, 2006). The term has become popular in describing methods that leverage mass collaboration or community-based design, enabled by the evolution of Internet-based Web 2.0 technologies and tools. Crowdsourcing events can be hosted on interactive Web sites, within databases, on blogs or using similar applications. Many Crowdsourcing principles can be linked to both Open Source and Open Innovation business practices. People choose to participate in Crowdsourcing events to demonstrate their knowledge or indulge their interest in a subject or for altruistic reasons. Some participate by just completing a survey. Crowdsourcing is not without flaws. If a project does not attract enough participation, it can end up costing the developer more than paying knowledge workers to complete the project. However, successful examples of Crowdsourcing have changed the standard business model or practices for some entire industries: Wikipedia changed encyclopedias, iStockphotos changed the stock photography industry and Linux changed the software industry.

The new Web-based applications described above are most widely known for their social networking and online data warehousing capabilities. The consumer has embraced these technologies for their personal enrichment. Private industry is starting to explore the technologies' potential in the business context to open new markets. However, the U.S. government lags behind in this trend. This project supports the government's use of innovative Internet-based tools to explore the potential of mass collaboration to bring together academic institutions, commercial research organizations and the government into one network. These new business strategies and Web-based applications have a strong potential to improve efficiency, and thus reduce the cost of creating and updating knowledge databases in real time, collecting and instantaneously

disseminating information to pertinent personnel, and improving communication between program stakeholders. It is therefore problematic for the government to ignore this movement.

III. LITERATURE REVIEW

A. INTRODUCTION

This literature review examines works in three conceptual areas that make up Crowdsourcing. In the first work, *Wikinomics: How Mass Collaboration Changes Everything* (2006), Don Tapscotts and Anthony D. Williams explore the potential of Web 2.0 tools in the business environment. The authors introduce the readers to Web 2.0 concepts and tools, which enable Internet-based collaborative work environments and social networking. The book contains numerous examples of organizations using Web 2.0 technology to harness the collective aptitude of open networks and expert knowledge to drive organizational innovation, development and growth.

The second work, *Open Innovation, Researching a New Paradigm* (2006), is a series of essays written and edited by Henry Chesbrough, Wim Vanhaverbeke and Joel West, offering an academic study of Open Innovation. Open Innovation is an antecedent to Crowdsourcing. It embraces the ideals of soliciting ideas, recruiting specialized labor from administrative workers to business professionals, software engineers and experienced scientists for specific, often short term, projects and beta testing products and concepts from a network of interested organizations. Henry Chesbrough, the Executive Director of the Center for Open Innovation at the Hass School of Business at UC Berkley, and his co-authors have researched and written a series of academic essays and several books on Open Innovation, investigating best business practices surrounding the subject. The authors' combined knowledge and experience provide a foundation and structure that can be adopted by future Crowdsourcing practitioners.

Last, James Surowiecki's *The Wisdom of Crowds* (2005) examines if there is value to crowd decision-making, and under what the circumstances. Surowiecki (2004) examines sociological theories, drawing from biology, behavioral studies and computer science to answer the question of whether large groups of individuals are wiser than a single expert, and what the best practices surrounding group decision making are (Surowiecki, 2004). The combination of these three works gives insight into the potential

of Crowdsourcing, the scope of current and future applications, its boundaries, and the technological tools and personnel training necessary to use Crowdsourcing effectively.

B. WIKINOMICS: HOW MASS COLLABORATION CHANGES EVERYTHING

1. Introduction

Wikinomics: How Mass Collaboration Changes Everything (2006), by Don Tapscotts and Anthony D. Williams, introduces Web 2.0 concepts and tools that enable Internet-based collaborative work environments and social networking. The authors argue that users originally used the Internet to view static Web pages, a one-way push approach to distributing information. Web 2.0 enables a paradigm shift toward a two-way push-and-pull dissemination of information, with users actively creating content, participating online in self-organizing teams and socializing virtually rather than just passively accessing information. The authors, therefore, call Web 2.0 the programmable Web.

Further, the authors discuss background and recent trends in Internet-based collaborative communities, such as how collaboration facilitates new product development. In addition, the authors introduce approaches and procedures that facilitate such participation. *Wikinomics* (Tapscott & Williams, 2006) helps the reader understand the advantages of Web 2.0. The authors assert that the prevailing hierarchical top-down command-and-control organizations are challenged and superseded by flatter and more nimble organizations that use self-governing cross-functional teams and groups to their advantage.

According to *Wikinomics* (2006), Tapscott and Williams (2006) build their business model based on four ideas: openness, peering, sharing and acting globally. These concepts are explored below:

Openness: Openness normally refers to positive ideals such as candor, transparency, freedom, flexibility, engagement and access (Dictionary.com, 2009). However, in this case, the authors are also referring to closed and secretive corporate cultures, and how they need to develop new attitudes toward networking, sharing and encouraging self-organization. For example, companies need to open their doors to a

more diverse global talent pool to remain at the forefront of their industry. Additionally, companies must be more willing to accept open standards or open systems, such as Linux operating system, MySQL for databases and Firefox as a browser, because customers are asking for them. Companies must embrace transparency so that customers respond to their openness by returning trust.

Peering: Organizations typically are organized in a vertical hierarchical fashion. This structure has been epitomized and perfected by military organizations throughout history and copied by governments and large traditional organizations. Hierarchical businesses typically organize their workforce into executives, managers, supervisors and workers, because this structure has a proven track record for managing disparate locations and divisions in an orderly manner. However, according to *Wikinomics* (Tapscott & Williams, 2006), peering is developing into a competitive organizational structure that is horizontal and depends on self organization. Henry Mintzberg, in the *Harvard Business Review* (HBR, 1981) called this kind of structure "adhocracy," which he states works best in organizations specializing in complex and creative innovations or writing detailed expert analysis and reports. In "adhocracies" or peering, experts lead projects based on their interest in the subject rather than on their position in the firm. This business environment is characterized as very fluid, dynamic and complex. Additionally, decision making depends on informal lines of communication and mutual consensus, resulting in cross-matrix teams and control shifting to whomever is the best expert to make a particular decision.

Mintzberg (HBR, 1981) identifies firms involved in aerospace technology and petrochemical research, think-tanks doing consulting and the film industry as examples that best exemplify adhocracy organizational structure, which Tapscott and Williams (2006) call peering. They state that such knowledge-based companies have the greatest potential to take advantage of peering. Examples of successful peering projects include the development of Linux software and the organization of Wikipedia, the online encyclopedia. Marketocracy Capital Management is another organization using a peer-to-peer model, linking consultants and volunteer-users in order to gather and condense the investment community's collective knowledge into an investment group. *Marketocracy* is

a research service whose mission is to find the best investors from around the globe and then follow and analyze their trading activity in order to aggregate the top 100 portfolios. Data on these portfolios is then compiled and analyzed to create a family of mutual funds. The *Marketocracy* m100 Index has beaten the S&P 500 Index in eight of the 11 quarters since its inception (Marketocracy.com, 2009).

Sharing: The authors of *Wikinomics*, Tapscott and Williams (2006), define sharing as the control and protection of proprietary items and innovations, predominantly intellectual property (e.g., trademarks, copyrights and patents). Companies, in general, protect their intellectual property (IP) by legal means through court cases. However, within the precepts of sharing, companies have several IP strategies. One method is openly sharing the information, basically giving it away and allowing other companies to build the IP into their products. The IP is then used to tie the products to ancillary or auxiliary equipment. For example, cell phone providers give away their network software in hopes that cell phone manufacturers will build and market cell phones that work on their network. Cell phone providers earn extra capital by marketing e-mail services, walkie-talkie services, Internet services and GPS services, to name a few. Another IP sharing strategy is for organizations and companies to combine resources and build a community of developers to create a standard. IP that is communally standardized is found in many everyday products, such as computer USB connections to allow auxiliary equipment to quickly connect into any computer and perform. VCRs, CDs and DVDs also depend on standardized software to load or read data when they are running on any supporting device. Even a number of pharmaceutical companies shared IP with government laboratories, private organizations and universities, in hopes of aggregating biological research to build a genetic database. The Human Genome Project, as the database is known, is used to further the study of the human genetic makeup and to research the possible sources of diseases. CAMBIA, a non-profit organization, operates a similar database that collects donated IP pertaining to life sciences technologies. This database is open to anyone.

The goal of such endeavors is to encourage online collaborations between diverse research groups and provide open access to anyone who wishes to improve or create

innovations based on their collection of IP, either commercial or non-commercial. The authors of *Wikinomics* (Tapscott & Williams, 2006) reference Tim Bray, director of Web Technologies at Sun Microsystems, as saying that the sharing of IP expands markets and provides new opportunities.

Acting Globally: In the past, some multinational organizations allowed their international divisions to run as independent fiefdoms, as long as they sold their parent company's American-produced goods, and provided an acceptable return on investment. However, this business model restricted them from taking advantage of sourcing material and other resources globally and/or taking advantage of organizational synergies, such as capital and highly trained specialists. Presently, global organizations are re-learning the skills needed to act globally. Increasingly, organizations are taking advantage of international developments, tapping into a larger global talent pool and creating global business alliances. Acting globally supports peer production across national borders, time zones and cultural divides in order to access new markets more quickly and uncover new technologies or ideas that can be used in any area of the organization. A true global organization transcends physical or regional boundaries. Rather than centralizing control, it builds and locates its resources for design, sourcing, manufacturing and distribution with global partners and small satellite companies. Industries that are most successful in working and acting globally are the semi-conductor and pharmaceutical industries, as well as oil and gas services.

The authors state that these guiding principles are replacing older business doctrines in fields such as R&D, product development and manufacturing. For centuries, scientists in academia published their research, which was reviewed and analyzed by their peers prior to acceptance. Consequently, peer-reviewed academic research and the resulting discoveries laid the groundwork for future research. Therefore, the authors perceive the traditional peer evaluation method for producing knowledge and sharing information as standard operating procedure in today's business environment. Similarly, they see Web 2.0 as a modern-day example of the same principle.

The authors argue that Web 2.0 technology is driving businesses into new territories. Firms with a talent for facilitating interactive peer review and managing an

online collaborative work environment to source "pre-competitive" information from customers, suppliers, and R&D pools, such as universities and private organizations, are enjoying a competitive edge in a knowledge-based economy. Such activities are defined by Wiktionary (Wiktionary, 2009), an online collaboratively written dictionary, as "the act of gathering commercially meaningful information in collaboration with competitors in the early stages of development."

For example, Eli Lilly formed a consortium with a number of other pharmaceutical and medical research companies, government agencies, universities and non-profit organizations, to bring together biology and information technology to search for "pre-competitive" information in the life sciences. This consortium, the Life Science Grid (LSG), links multiple public and private databases containing research data and scientific journal articles on biology, genetic codes, neurology, pharmacology and medical knowledge as well as patient statistics. The European Bioinformatics Institute (EBI) operates very similarly to the LSG, but it networks private European databases. Members of such a consortium use complex search algorithms to scour the stored data for patterns and to analyze the data for relevant information. The knowledge distilled from these sources gives consortium members a competitive edge by accelerating the speed of drug research, new diagnostic tests and medical procedures and devices.

In addition to benefits that pre-competitive information brought to R&D, Tapscott reminds the reader that organizations in consumer markets also will find that pre-competitive information leads to strategic advantages in their business models and operations. For example, Macy's, a traditional brick and mortar department store founded in 1858, has adopted Web 2.0 technology for various purposes. Macy's Facebook page, Blog and Twitter messaging drive new business to their stores and Web site and help build customer loyalty. To improve their customers' online experience, in 2008 Macy's invested approximately $300 million in Web, phone and mail business (Duff, 2008). Macy's online strategy aims to enhance their customers' in-store shopping experience, making special coupons available only online, and building seasonal Web sites that combine entertainment and charity with shopping in order to build Macy's brand recognition and brand loyalty. Macy's also posts short entertainment videos as well as

music and fashion clips on YouTube to appeal to the youth market and on Macy'sTV for the more mature customer. Macy's main Web site invites customers to build a personal profile in return for coupons for their favorite brands or special-event invitations. Macy's also keeps a Web site dedicated to hiring new employees: posting their job opportunities and accepting applications. Furthermore, Macy's communicates to investors through Webcasts and podcasts posted to its corporate Web site. Mike Duff (2008), in his article published on BNET, quoted a Macy's spokesperson as saying that sales attributable to "macys.com and bloomingdales.com rose by 23% in the third quarter of 2008, and by 32% in the first nine months of fiscal 2008. With roughly 750,000 daily visitors to Macy's online Web sites, Macy's expects its direct business to generate about $950 million by the end of 2008."

Tapscott advises organizations to prepare to accept the principles of openness, peering and sharing if they are planning to compete globally (Tapscott & Williams, 2006). The authors predict that businesses that do not learn to leverage Web 2.0 technologies run the risk of becoming less competitive and less able to communicate with and attract and retain the younger generations within the workforce than their more innovative competitors.

2. Web 2.0 Collaborative Principles

Users experience Web 2.0 technologies on Web sites that allow participants to collaborate on their very production and maintenance. Users input and edit much, if not all, of the content on these Web sites. Examples of Web 2.0 technologies include blogs, picture-sharing, vlogs, wall-postings, e-mail, instant messaging, music-sharing, group creation and voice over IP, to just name a few. An important category of Web 2.0 technologies are the social media tools, which are becoming popular with all Internet users. Social media Web sites depend on users to create content on their Webpage, as found on Internet forums, message boards, weblogs, Wikis, podcasts, pictures and video. The authors point out that these social media tools can help to facilitate creativity, collaboration and sharing within Web-based communities and their host services providers.

Wikinomics (Tapscott & Williams, 2006) outlines the basics of Web 2.0 technologies and social-media tools. It discusses how the designers of Web 2.0 technologies first intended them to function, and how the marketplace found additional unexpected applications. The emergence and growth in popularity of Wikipedia, an interactive online encyclopedia, which is free to online readers and written and edited by volunteers, was entirely unforeseen. Wikipedia was originally intended by its creators to act as an information feeder project in order to provide supplemental information and draft articles for a professionally written online encyclopedia called Nupedia. Nupedia was overtaken by Wikipedia's popularity, and Nupedia's creators eventually closed down the project. For many Internet users, Wikipedia is the eminent source of reference information in over 20 languages. Wikipedia is supported by a non-profit organization, the Wikimedia Foundation, which provides the Web site and software that has allowed contributors and volunteers to collaborate and edit over 10 million articles to date.

In that same vein, Second Life™ was originally designed as a networking forum for game players, but because of user generated content, Second Life™ has now morphed into an important setting for organizations, political forums and university lecturers to commune and collaborate. Moreover, YouTube, which started as a personal video sharing Web site, has become a source for current events and news captured on video.

3. Open Innovation

Tapscott and Williams (2006) also explain how organizations, such as IBM, Proctor and Gamble (P&G) and InnoCentive, currently use Web 2.0 tools and technologies, such as Internet forums, message boards, Weblogs, Wikis and podcasts, and social media to develop Open Innovation strategies. The central idea behind Open Innovation is for participants and companies to access knowledge both within and outside their firm. Therefore, they are no longer limited to their own researchers and developers, but can augment their own R&D processes with material from outside sources. Thus, companies buy or license patented products and processes from participating companies. Since many companies do not use 70–90% of the innovations they develop (Tapscott & Williams, 2006, pg 102), they may benefit from sharing these ideas with other companies

that may utilize them for new product development. Open Innovation depends on corporate R&D departments, freelance engineers and professors participating in open discussion Web sites. On such sites, researchers post questions, problems, or product concepts, and solicit other participants for feedback, ideas or knowledge. Open Innovation forums work with companies to open their R&D files for viewing and for use by other firms and individuals without the need for pre-licensing agreements or direct payments. The idea is to allow another company to improve or develop a marketable product leveraging the innovator's invention.

Companies and researchers benefit equally from this virtual workplace by sharing knowledge as well as by licensing or selling their inventions, patents, or product rights to one another. In contrast, companies that maintain a closed innovation system limit the use of their firm's internal knowledge and make little or no use of external knowledge. The authors believe that the open exchange of innovation prevents companies from wasting resources by "re-inventing the wheel." It also helps them develop new products and move them to market faster. P&G, for example, is an early adopter of consumer product development through Open Innovation, a concept it successfully embraced after a reorganization of its research and development departments in 2000. P&G's management understood that sustaining an annual growth rate of 4%–6% (P&G Web site, 2009) was becoming too difficult, and decided to make a remarkable cultural change from a closed development business model to an open business model. P&G estimates that this move expanded its access from 9,000 to 1.8 million researchers by the beginning of 2000 (P&G Web site, 2009). Rather than restricting its research to internal departments, P&G now seeks business opportunities with individual innovators, small and medium-sized business partners, and collaborates with universities, spin-offs, corporations, capability and service providers, government funded R&D organizations, venture capital firms and other partners.

P&G's Connect & Development[sm] Web site (pgconnectdevelop.com, 2009) invites innovators to submit proposals for new products and packaging ideas, and solicits improvements to its existing products. In addition, P&G invites innovators to browse its online inventory of intellectual property. According to P&G's Web site (2009), Open

Innovation techniques helped P&G acquire the technology for Bounce dryer sheet fabric softener from a Canadian inventor. The technology to produce a key peptide for an Olay anti-wrinkle cream was developed by a small firm in France. P&G also formed a joint venture with its competitor, Clorox Pty Limited. P&G provides this joint venture with its intellectual property and global marketing expertise for Glad's Press'n Seal plastic bags and its ForceFlex trash bag technologies. Clorox Pty Limited's contribution to the joint venture is its brand equity, its expertise in plastics and resins, and its distribution channels for plastic film products.

Open Innovation has helped P&G sustain its market growth between 2000 and 2006 and reduce cost at the same time. By 2006, 35% of P&G's new products contain technology developed outside of the company (Huston & Sakkab, 2006). P&G introduced over 100 new products to the consumer market, with its R&D productivity increased by almost 60% (Huston & Sakkab, 2006). During the same period, P&G's cost of innovation fell from 4.8% of sales in 2000 to 3.4% in 2006 (Huston & Sakkab, 2006).

a. Open Source, the Precursor to Open Innovation

Tapscott and Williams (2006) follow the natural progression from Open Source development to Open Innovation. Open Source is associated with software development. It was made famous by Linus Torvald, who helped develop and promote Linux, an Open Source operating system for personal computers and Web servers. Linux is not owned by any one individual or organization since it was developed by volunteer experts. Linux is, therefore, free to all users and its code can be modified and customized.

Open Source differs from Open Innovation on patent issues. Under an Open Source system, patents are not mutually exclusive. Patents are donated by participating companies to an independent organization, which makes them available in a common patent pool or grants limited licenses for unlimited free use.

IBM advocated and adopted the Open Source concept early on. In the 1990s, IBM was struggling with its business model and, after witnessing the advantages and the success of Linux, decided to develop their products as Open Source. Instead of generating revenue by selling their patent-protected standard software, they created value

by offering customized software solutions and individualized service to their customers. IBM first published its source code on the Internet, allowing software developers to integrate IBM software into their consumer products and custom design applications for their commercial customers. Then they began delivering the premier service that made IBM famous. The authors report that adopting the Open Source business model propelled IBM from a declining hierarchical conglomerate into a fast-moving creative and innovative player in the computer server and mainframe industry.

A few companies allow products, such as the online retailer Amazon.com, Apple's iPhone and social networking Web site Facebook, to open their information technology (IT) platforms and infrastructure, including their source code, for third parties to create modifications with value or suggest modifications in innovative ways. This means, third parties have access to a company's proprietary software code and virtually all of its product data, in order to build Web sites that direct customers to additional Web sites that offer complementary products and services. The benefit for a company in sharing its source code is that it makes it easier for a second company to build compatible applications and services, which creates more demand for both companies' products and drives more traffic to both Web sites. The premise is that if organizations open up certain assets and invite people to modify them, the speed, scope and penetration of the innovation is accelerated. Amazon.com utilizes an open platform to attract over 140,000 free software developers (Tapscott & Williams, 2005, pg 259). Thirty percent of its revenue comes from 975,000 third-party retailers who leverage Amazon's e-commerce platform (Tapscott & Williams, 2005, pg 194 and 276). Third-party sellers and Web site developers receive a single digit percentage-based commission on the revenues they create for Amazon, so everyone wins.

4. Crowdsourcing

The term Crowdsourcing is popular shorthand for the methods or processes that leverage mass collaboration by exploiting Web 2.0 technologies and by utilizing Open Source ground rules to achieve a specific goal. Crowdsourcing allows an individual or organization to invite the consumer or the general public to participate in the

development of a new product. This can take the form of writing software, doing research, writing and editing or creating content for a Web site, designing components or a new product. The authors of *Wikinomics*, Tapscott and Williams (2006), describe Crowdsourcing as a collective process used to develop a product, create Web site content, analyze and/or organize information. A condition required for Crowdsourcing is that an indeterminate, large group of people work cooperatively and collaborate as equals on a project, which changes an organization's business model in startling but eventually profitable ways (Tapscott & Williams, 2006). Tapscott and Williams (2006) feel that Crowdsourcing will have a great impact on the arts, education, government and science. Crowdsourcing outsources the labor required to complete a project to an Internet-based open group of people instead of working with corporate teams, individual employees, or subcontractors.

An individual's participation in a Crowdsourcing event is not based on expertise and credentials. Participants often range from interested amateurs to experts in the traditional sense. In addition, there is no formal contract between the parties. Rather, the organization running the Crowdsourcing event can employ intrinsic, extrinsic and explicit incentives. Some organizations, for example, confer titles such as "master" or "grand master" to certain participants or acknowledge them with a special mention on a Web site listing accomplishment. Such mentions can strengthen a participant's resume. Other organizations may offer a monetary award for the best idea. Most organizations, however, ask people to participate for fun.

Crowdsourcing projects are normally announced over the Internet. A network of interested individuals gathers online to discuss ideas and postulate solutions. Collaboratively, this network or "crowd" determines the best solution to the problem. Following this decision, the network breaks the project down into ever-smaller tasks or clusters of tasks. Individuals then organize themselves into teams based on knowledge or interest, and dedicate themselves to solving only this specific task. An individual may choose to join several teams or focus on one task at one time. Sometimes, the person or corporation that initiated the project offers a prize as an incentive to the person or team that develops the most practical solution. However, many Crowdsourcing participants are

true volunteers who work on these projects during their free time, with building a reputation or receiving compliments as their only incentive. The best contributions of the numerous teams are then assembled into a viable product.

Organizations that adopt Crowdsourcing methods often access a broader range of talent, thus increasing the effectiveness and efficiency of product development, lowering the cost of production, gaining customer insight and, possibly, converting intellectual property into revenue. However, the authors argue that in order for companies to leverage this technology, they must be able to make monumental changes in their organizational structure, corporate culture, modus operandi and sources of revenues to convert from their current closed system to a new open system of innovation. Organizations have to determine how they will incentivize and award valuable participants of their Crowdsourcing projects. Organizations also have to limit the risk of exposing their intellectual property and jeopardizing their current sources of revenue in anticipation of generating greater future profits from collaborative efforts.

The following is a description of a successful Crowdsourcing project.

a. Linux

Linux is a new computer operating system that started emerging in the mid 1990s. Running unseen in the background, it manages other applications that the computer user is aware of and familiar with, such as word processors, spreadsheets and e-mail programs. The Linux operating system is comparable to Microsoft's XP. However, the two operating systems differ greatly in their ownership: XP is a proprietary product owned by the Microsoft Corporation who maintains it, updates it and sells it to consumers. Linux, on the other hand, is available free of charge. It is owned by a non-profit organization and maintained by a large group of volunteers. Proponents of the free software concept like the idea of being able to edit, improve and add personalized software applications to Linux code and share their ideas in online communities. Linux has been adapted to run on all types of hardware including personal computers, embedded devices, mobile phones and supercomputers. However, Linux is now mostly known as a server and Web server operating system.

Linus Torvald, the creator of Linux, claims to have written only 2% of the software code that makes up the current version of Linux (Bellevue Linux Users Group, 2006). The rest was written by its users and enthusiasts. Linux is successful because its users act as programmers and software developers. They gather in online user groups, chat rooms and online professional networks, and identify problems to be solved. They exchange software patches or bits of code that fix problems and share their ideas for future projects. Newsgroups and magazine publishers, software companies like Red Hat and Oracle, and hardware manufacturers like IBM, HP, Nokia and Sun Microsystems offer employees time and resources to collectively work with user groups to seek solutions and to improve the efficiency and robustness of Linux. The non-profit Linux Foundation monitors these user groups and incorporates the best ideas into future versions of Linux.

The Linux non-profit business model differs from that of companies selling proprietary software. Linux utilizes a free software license, which grants users the right to modify or upgrade the software and then distribute it. Normally, software companies have copyrights on their products, which allow them to retain all exclusive rights for a limited period and prohibits others from copying and/or distributing their work without permission. Linux free software license provisions state that modified versions of the software become available. However, future versions of Linux software must be distributed under the same terms as the original license. This ensures all future versions of the software retain the free software license.

5. Paradigm Shift

Wikinomics (Tapscott & Williams, 2006) stresses collaborative principles as a new organizational framework to create new business opportunities. The book describes a series of business concepts and approaches that lead to rapid, collaborative change. The authors call their most prominent concepts Peer Pioneering, Ideagoras, Embracing the Prosumer and the New Alexandrians (Tapscott & Williams, 2006, pg 32). These concepts are described below:

a. Peer Pioneering

In peer pioneering, individuals and organizations indirectly create business opportunities by participating in open-source projects. In a new way, the production of goods and services harnesses the power of mass collaboration when allowing individuals to organize themselves within virtual communities, coming together voluntarily in order to pursue to a common goal (Tapscott & Williams, 2006). Tapscott and Williams support their belief that "peer production is emerging as an alternative production model that harnesses the skills integrality, and intelligence of many more efficiently and effectively than traditional firms" (Tapscott & Williams, 2006, pg 66). According to the authors, peering works best under three conditions: "(1) the object of creation is information or culture, which keeps the cost of participation low; (2) tasks are chunked into small pieces where individuals can contribute in small increments; (3) the cost of integrating completed fragments of information into the final product must be kept low" (Tapscott & Williams, 2006, pg 70). According to the authors, the results and the benefits achieved in the creation of the final product outweigh the overall investment of time and energy spent creating the product (Tapscott & Williams, 2006).

Examples of peer pioneering were previously discussed in Linux's Open Source software development, where dispersed volunteers collaborate in order to create and update an innovative product on a continuous basis. Linux's popularity and low cost have made it the world's third-largest desktop computer operating system, after *Microsoft Windows* and Apple OS, with a small 2% market share, but an annual growth rate of approximately 80% (Assy, 2009). Another example of peer production is *Wikipedia*, which utilizes volunteer writers and editors to create, edit and update content and exert quality control. Updates are made in near real time because of the number of loyal contributors. Today, *Wikipedia's* business model has outperformed the Encyclopedia Britannica, a large, well-established traditional firm.

b. Ideagoras

Ideagoras are Internet sites where businesses can post their R&D problems and request and gather solutions. Ideagoras enable top companies to tap global scientific

talent for consultant activities without hiring additional personnel. The consultants or informal problem solvers post solutions to commercial problems published on the site and are paid for workable solutions. Additionally, organizations publish and offer for sale their unused patents and other secret innovations and intellectual property, which would otherwise remain dormant without commercial use. In brief, these Web sites match commercial problems with technical solutions.

Ideagora Web sites operate like online marketplaces for innovations, matching buyers with sellers. They include InnoCentive, NineSigma, InnovationXchange Network, Eureka Medical, YourEncore, and Innovation Relay Center.

InnoCentive.com is an example of a successful Ideagora. *InnoCentive* describes itself as a Web-based community matching scientists to relevant R&D challenges faced by leading companies from around the globe. *InnoCentive* has approximately 175,000 engineers, scientists, inventors, business people and research organizations in more than 175 countries who are invited to solve a wide variety of challenges. (*InnoCentive.com*, 2009). Commercial corporations and non-profit organizations that use *InnoCentive* for external ideas and solutions include Procter & Gamble, Avery Dennison, Pendulum, Eli Lilly and Company, Janssen, Solvay, GlobalGiving and The Rockefeller Foundation (*InnoCentive.com*, 2009).

InnoCentive mediates their Web forum of scientific experts from around the world. Some of their experts are full-time scientists, while others are part-time scientists, retirees, or students and tinkerers. Accessing an Ideagora like *InnoCentive* essentially allows corporations to seamlessly integrate a dispersed network of independent scientists into their corporate R&D department and pay for performance only (*InnoCentive.com*, 2009).

When Procter & Gamble develops a new product, it sometimes bypasses in-house researchers and posts its requirements on *InnoCentive*, offering a financial incentive for the best solution. In *Wikinomics* (Tapscott & Williams, 2006), Tapscott gives an example of a large company researching a new molecule to remove stains from clothing. This organization may have access to a few thousand scientists within their

organization's boundaries. However, accessing an Ideagora like *InnoCentive* can supplement their research efforts by adding the ideas of several million minds outside their boundaries. This is a tremendous augmentation of a company's internal resources, which multiplies the chances that someone, somewhere in the world, will come up with a workable solution or at least a first blueprint toward this molecule.

An example given by the authors is Procter & Gamble's solution to printing animal characters on Pringles potato chips. Proctor & Gamble published their technical requirements on *InnoCentive*. An Italian bakery had already perfected the technology and responded with a practical solution for which they received a monetary reward. Tapscott predicts this type of development can enable small businesses to access otherwise unaffordable R&D and thus make them competitive with larger firms (Tapscott & Williams, 2006). Proctor & Gamble has become so successful at managing its intellectual property that its R&D department has gone from an expense on its Profit and Loss statement to generating revenues and profits. Proctor & Gamble publishes some of its technology and intellectual property on yets2.com, either for sale, leasing or licensing, allowing Proctor & Gamble to collect a return on its investment.

c. Prosuming

Consumers now play a far greater role in the creation of a product. Prosumers are customers who "hack" products and insert additional useful software routines, thus creating new features or applications that a manufacturer did not anticipate and did not provide for. In this manner, Prosumers participate in the creation and modification of products such as the online social network game *Second Life*™ as well as Lego's Mindstorm™ construction toy and Sony's robot dog Aibo™. Fans and hobbyists hack Aibo's computerized parts and write new code. These software patches are posted online, allowing other consumers to download software patches into their toys that give them unique personalities. In addition, owners of the Toyota Prius have hacked into its electronic system to modify the car's internal software so that the Prius runs further on electric power (Terdiman, 2006), or runs movies and the Internet on the dashboard

electronic display (Autoblog.com, 2009). Prosuming is also becoming common in music re-mixing, where consumers dissect music into digital components and re-assemble them into custom melodies.

Initially, some companies threatened to sue hackers. However, others accepted that consumer-initiated product modifications can accelerate a product's popularity with innovators and early adopters. Such modifications can be incorporated into later versions of a product, making it more interactive or easier to use and creating broader popular appeal within the general public.

d. The New Alexandrians

The "New Alexandrians" are an online community of scientists in favor of breaking down the proprietary barriers in the sciences (namely in the fight against diseases) and releasing corporate holds on information. They envision open access research libraries, which disseminate pre-competitive information and distribute information between research firms for pre-publication peer review. The authors cite recent examples of pharmaceutical research companies seamlessly sharing information in collaborative virtual communities, with the goal of eliminating inefficiencies typically associated with research. According to Tapscott and Williams (2006), the prospective benefits of online communities are:

- the rapid diffusion of best-practice techniques and standards
- the stimulation of new technological hybrids and recombination of commercial products
- the availability of "just-in-time" expertise and increasingly powerful online tools for conducting research
- faster positive feedback cycles from public knowledge to private enterprise, enabled by more nimble industry-university networks
- increasingly horizontal and distributed models of research and innovation, including greater openness of scientific knowledge, tools and networks (Tapscott & Williams, 2006, pg 156).

Firms that practice an open and collaborative business model are able to access expertise on demand. These firms build collaborative networks with business

partners and work in virtual environments that enable sharing of information through open knowledge centers or databases and the use of open standards in product design. They allow open viewing of their intellectual property and scientific work, and work with other organizations in open research and development consortia. The list below describes several successful commercial collaborative efforts that exemplify what Tapscott and Williams (2006) describes as the New Alexandrians.

Among the success stories described by Tapscott and Williams (2006) are the following:

- Starting in 1999, more than a dozen pharmaceutical companies abandoned their proprietary human genome projects in order to support open collaborations such as the SNP Consortium and the Alliance for Cellular Signalling.
- Efforts, such as the Google Book Search, the Public Library of Science and the World Digital Library are trying to create libraries with free-access journals building on the open-access concept. Harvard has recently joined the movement by electing to post research from the arts and science faculty free on the Internet.
- Collaborative design projects include Intel's Open University Network which is working to grow markets for its products. In addition, MIT's OpenWetWare shares ideas in biology using Wikis to swap data, standardize protocols and to share material and equipment. Twenty other labs are working with MIT at this time.

6. Manufacturing in an Open Innovation Setting

Manufacturing industries are taking advantage of a virtual global marketplace for designing and building physical products. Tapscott and Williams (2006) believe that where intellectual property is minimal, and production capacity is divided among hundreds of specialized firms, industries will benefit most from collaborative processes. The leading manufacturers of semiconductors, computers, cars, clothing and bicycles are for the most part only responsible for product conception and marketing to the global marketplace. They outsource manufacturing and most, if not all, aspects of component design. Moreover, they build a reliable global infrastructure consisting of hundreds of specialized firms to assemble and package their finished products.

Tapscott and Williams (2006), provide some guidance on outsourcing and assembly to a worldwide network of firms. The principles below are quoted from *Open Innovation*, "The Global Plant Floor," and provide guidance on how to get the most out of new Web technologies:

- Focus on the critical value drivers. Organizations need to focus on what is best for the customer, thus creating greater customer value. Organizations can than partner for everything else.
- Add value through orchestration. Orchestrate global collaboration, finding disparate partners and seek rewards in globally integrating processes and designing and making products.
- Instill rapid, iterative design processes. Open networks or communities that seek out motivated partners working within their field of expertise can accomplish rapid design and testing. Informal, decentralized networks of companies, suppliers and consultants lead to modular organizational designs and architecture. Modular design lends itself to the integration of components into subsystems and more complex systems, leading to rapid prototyping and the bringing of solutions to the market faster.
- Harness modular architectures. Open organizations that work with their network on product standards and modular architecture benefit from wide market acceptance in commercial products.
- Create a transparent and egalitarian ecosystem. Open organizations cannot support undue secrecy and a win-lose attitude with their business partners. Practices like these become counter-productive within their community. Benefits come from end-to-end visibility across the supply chain when networks of suppliers can add value to processes, improving performance and helping to lower cost.
- Share the costs and risks. When network partners share risk, they are motivated to help bring a successful product to the marketplace. However, the lead organization must allow their risk sharing network partners to share in the decision making.
- Keep a keen watch on the future. Be observant of changes in the global marketplace to find opportunities, even in industries a company normally would not partner with" (Tapscott & Williams, 2006, pages 235–238).

In business, some organizations may view mass collaboration as an extension of the trend to outsource formerly internal business functions to other business entities. The difference, however, is that instead of a business venture serving a specific outsourcing function, mass collaboration relies on free individual agents to come together and cooperate to improve a business operation or solve a problem.

Tapscott and Williams (2006) describe some newer developments of subcontractors organizing themselves within networks to strengthen their respective businesses. In China, for example, large corporate manufacturers such as Honda and Yamaha do not dominate the motorbike industry; rather, it is small manufacturers that are outsourcing tasks to even smaller subcontractors who specialize in only a part of the production. The manufacturing specialists find ways to drive down costs with continuous improvement and standardized parts and designs.

7. Summary of Key Ideas and Findings

Wikinomics introduces the reader to a business model that marries Web 2.0 tools, user-generated media and social networking technologies in order to develop new products and services. According to *Wikinomics*, these business practices are centered on the four basic ideas of Openness, Peering, Sharing, and Acting Globally. However, without providing specifics, Tapscott and Williams describe how businesses outsource some or all non-core functions to other organizations. Their outsourcing concept differs from traditional outsourcing in that it depends on Internet-based problem solving through the mass collaboration of free agents rather than depending on discrete organizations to sell their own unique products and services.

The outsourcing of idea generation and business functions using mass collaboration is known as Crowdsourcing. Crowdsourcing currently is used by organizations to help create consumer-driven ideas and products, and to source novel money saving processes. Sometimes, an organization offers incentives to participants with the purpose of encouraging a larger number of people into collective action, or mass collaboration resulting in a creative crowd sourced solution. Yet, incentives are not necessary for the model to function, and *Wikinomics* outlines many well-known organizations that conduct Crowdsourcing as an integral part of their business model without paying incentives. They depend on the collaborators to contribute for fun, altruism or public acknowledgement and respect.

Wikinomics also introduces seven feasible business practices rooted in mass collaboration, four of which are discussed in this report:

Peer Pioneering involves individuals and organizations who indirectly create business opportunities by encouraging participation in open-source projects. Both Linux and *Wikipedia* successfully utilized mass collaborators who volunteered to create, edit and update content and exert quality control over a product they enjoy.

Ideagoras are third-party Internet-based businesses that match buyers and sellers of ideas. *Ideagoras* are unique, in that they help organizations post their R&D problems and request and gather solutions from widespread global scientific and engineering communities. According to *Wikinomics*, the firm InnoCentive is a very successful *Ideagora*.

Prosumers are customers who "hack" products and insert additional useful software routines. In this way, they create new features or applications for a product that a manufacturer did not anticipate nor provide for. Prosumers are now leveraged by the developers of Second Life and Lego's construction toy Mindstorm since they collaborate on product modifications that the manufacturers will incorporate into future product revisions.

New Alexandrians are scientists who work together online to build open access research libraries. These libraries disseminate pre-competitive information and distribute information between research firms for peer review. The authors cite examples from Eli-Lilly and other pharmaceutical companies seamlessly sharing information with the goal of eliminating inefficiencies typical in early research.

Wikinomics serves as a guidebook explaining Web 2.0 technologies, Open Innovation and Crowdsourcing. It illustrates the benefits these concepts can bring to an organization. However, *Wikinomics* does not discuss how disruptive adapting these technologies will be to organizations and the marketplace in which they operate. In addition, *Wikinomics* lacks the research and insight necessary for organizations to plan for and manage the inevitable complex changes that these technologies will have on internal procedure and policies. These challenges, for example, include:

- How to create open access to innovations, inventions and patents
- How to develop the means to accept, evaluate and fairly value ideas from both internal and external sources and

- How to work jointly with one or more firms on a project without a way of anticipating the return on investment.

Thus, *Wikinomics* over-simplifies and skims over the structural problems associated with incorporating Web 2.0 technologies Open Innovation and Crowdsourcing into an organization.

C. OPEN INNOVATION—A NEW PARADIGM IN UNDERSTANDING INDUSTRIAL INNOVATION

1. Introduction

Open Innovation, Researching a New Paradigm (Open Innovation) (H. Chesbrough et. al., 2006*)* is a series of essays that offers an academic study of Open Innovation while introducing various Web 2.0 applications and discussing how they might be integrated into an organization's business strategy. The editors commissioned 15 academicians who specialize in innovation to offer their theoretical viewpoints, which are based on their own empirical studies into business organization.

The book is divided into three major sections. The first section discusses businesses that are implementing or practicing Open Innovation, reasons why organizations should seek outside information, whether organizations should choose incremental or radical change, the effects of external information on internal innovation and how traditional companies are changing their business models to include Open Innovation and how they are managing the process. The second section addresses how organizations are going to manage Open Innovation within their organization, and where and how to access external information. This section ends with a study of open standards, intellectual property and managing property rights within an Open Innovation setting. The third section discusses building networks, both internal and external to the organization. Further, it questions the value of making a disruptive change to an organization from a traditional to an open organization.

Open Innovation (2006) describes the strategic and managerial structure organizations need to develop in order to improve the efficiency and effectiveness of

R&D and product design and development. Open Innovation is the antithesis of the traditional vertical integration business model, and it encourages organizations to make more extensive use of internal and external R&D resources. However, organizations that adopt an Open Innovation business model must alter their normal business practices and culture in order to structure and institutionalize the outflow of information so that external researchers can view and use it. An Open Innovation business model calls for the continuous evaluation of both internal and external ideas to determine their potential value. Further, businesses adopting the Open Innovation model need to redefine their internal processes in order to extract value from unused intellectual property.

2. Open Versus Closed Innovation

Open Innovation is the antithesis to the "closed innovation model" (Chesbrough, 2006). Henry Chesbrough (2006) referenced Alfred Chandler's description of a closed innovation business model, which he characterized in his book, *The Visible Hand* (Chandler, 2006). Chandler states that the typical organization with a closed innovation approach is organized functionally with vertical report structures. If an organization believes successful innovation focuses inward and requires complete control, they are practicing a closed innovation model (Chesbrough 2006). R&D organizations employing a closed business model see themselves as self-reliant; they generate their own ideas, and develop, manufacture, market, distribute and service their products themselves. The closed innovation model gives an organization the ability to guard its intellectual property. With a closed model, organizations choose to market their intellectual property to others who purchase or license it, and they use legal methods in preventing competitors from copying and commercializing it. The closed model encourages organizations to be first to market and corner the largest portion of the market before the competition can enter the market. This closed innovation business model is best typified by Thomas Edison's Menlo Park Laboratory, which is recognized as the first industrial research lab, where he perfected the telephone, phonograph, electric railway, electric lighting and many other inventions. Menlo Park's success became the model for future

independent laboratories such as General Electric's Global Research Center, and for companies like DuPont and Bell Labs (AT&T Bell Laboratories) (Chesbrough, 2006).

Closed innovation research projects are launched and progress until, at some point, they are abandoned or selected for further development. Information from outside the organization is not solicited or even considered and, sometimes, neither is internal information from other business units. All too often, organizations utilizing a closed innovation model only favor information or research that their own development team has discovered. Under this system, few discoveries actually make it into commercial products, and too much R&D remains locked away in organizational libraries (Chesbrough, 2006).

Figures 1 and 2 demonstrate the difference between the closed innovation model and the Open Innovation model.

a. Closed Innovation Business Model

Figure 1 illustrates the closed innovation model from Henry Chesbrough's paper "The Era of Open Innovation" (2003, pg. 36), wherein each ball on the left side represents a research project entering an organization's closed development system and all projects remain within an organization's boundaries. The figure shows that, as innovations filter through the development process, review boards examine and analyze a project's progress. During this phase, many innovative projects are cancelled because of budget or time constraints, lack of organizational expertise to see the project through, or the final product or service do not fit the organization's business model. As the illustration shows, the number of projects is whittled down until only a few are actually marketed. Chesbrough (2006) states that traditional organizations that practice closed-innovation procedures will store or shelve innovations that do not make it to market in the hopes that funding becomes available or that they gain the relevant expertise necessary to integrate the innovation into a future product. Chesbrough estimates that only a small portion of innovations created actually make it from development to the market.

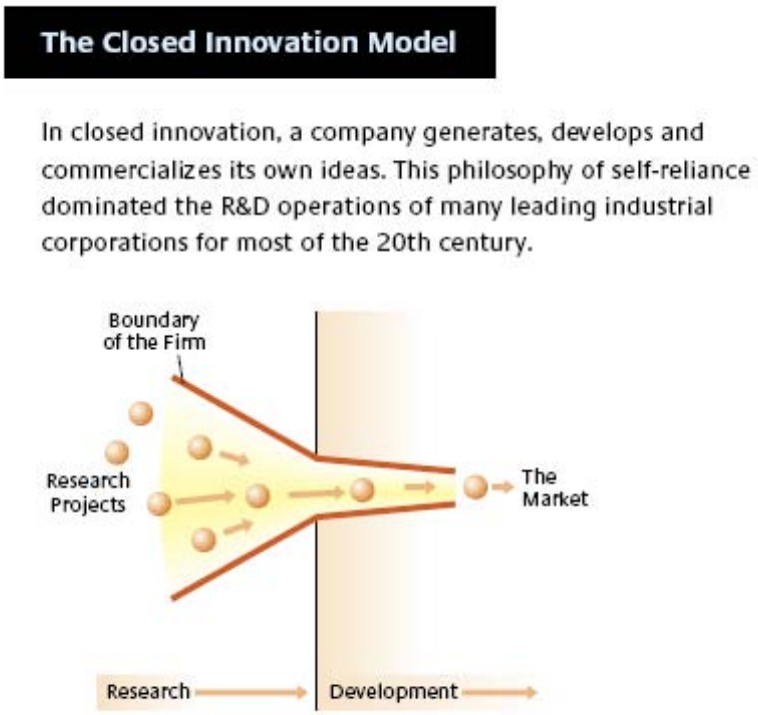

Figure 1. The Closed Innovation Model. From (Chesbrough, 2003)

b. Open Innovation Business Model

The Open Innovation business model differs significantly from the closed innovation model by the way it operates in the marketplace. Organizations that practice Open Innovation seek out knowledge both internally and externally. This is especially true during the earliest phases of concept development and basic research. Open Innovation principles are flexible enough that organizations can start and stop Open Innovation projects at any point along the development continuum because new technology can enter the process during various stages of a product's lifecycle.

Figure 2, from Henry Chesbrough's paper "The Era of Open Innovation" (2003, p. 37) shows how intellectual property, inventions and ideas transcend an organization's boundary in order to demonstrate how organizations practicing Open Innovation facilitate greater revenue generations. The firm's boundaries represent its normal capabilities. In the figure, the balls entering from the left (or the research) side

represent new projects. On the right (or the development) side are projects that are entering the marketplace. Figure 2 shows the firm's boundaries and the pathways projects or technology follow to move through the firm's boundaries. Figure 2 differs from Figure 1 because ongoing projects enter and exit the firm's boundaries on the research side. In this way, organizations that adopt an open model do not have to restrict themselves to their own projects, but instead can seek out other opportunities within their network by using another firm's technology to create a new product or by contributing their research to another organization's project. Chesbrough cites many organizations that are successful at managing Open Innovation and have greater revenue generation.

Additionally, Figure 2 shows that projects and technology exit out of an organization's boundaries. Organizations sometimes spin off, sell, lease or give away technology for a number of reasons. Small and medium-sized firms may allow other firms to bring their innovations to market because they themselves lack the capital, expertise, or distribution channels to properly market a product, or because the innovation is not a proper fit within the firms' business model. They can also sell or lease their innovations to be modified by another firm. Thus, organizations advocating Open Innovation capture value from intellectual property and technologies that do not easily fit within their own business strategy, and market them to other organizations in order to generate capital. Larger firms, whose stockholders require growth rates, will buy, trade and sell intellectual property to update established product lines or to break into a new market. Therefore, intellectual property is managed as a revenue-generating opportunity through licensing and/or product spin-off, when underutilized intellectual property is rented or sold to another company. Some firms market innovations developed by outside firms because they lack R&D capabilities but have developed multiple networks that provide pathways to broader markets.

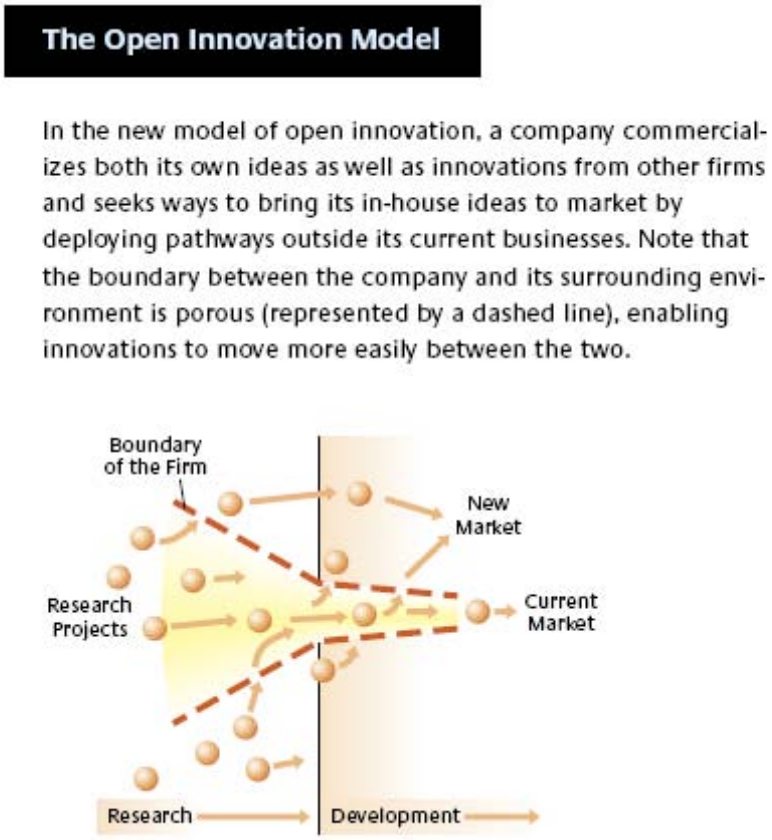

Figure 2. The Open Innovation Model. From (Chesbrough, 2003)

Moreover, organizations practicing Open Innovation can leverage their networks or use mass collaboration to test and debug their products at a low cost, conduct quality control, suggest product revisions and create new capabilities and functions. Additionally, the network offers a source of new ideas and an archive of intellectual property that can help reduce development costs. CNET reports that the American Intellectual Property Law Association estimated in 2005 that software patent lawsuits cost about $3 million (Perens, 2005) to defend. Given this high cost, a small organization could drive itself into bankruptcy trying to defend its patents in court. From both a financial and strategic point of view, it can make more business sense to out-innovate the competition rather than getting stuck in patent litigation. In addition, organizations can turn their patent archive into a source of revenue by allowing other organizations to license, lease or buy their patents rather than allowing the patent to expire.

In Table 1, Chesbrough (2003) summarizes the important distinguishing ideas between open and closed innovation:

Table 1. Contrasting Principles of Closed and Open Innovation. From (Chesbrough, 2003)

Closed Innovation Principles	**Open Innovation Principles**
The smartest people in our field work for us.	Not all of the smartest people work for us, so we must find and tap into knowledge and expertise of bright individuals outside of our company.
To profit from R&D, we must discover, develop and ship it ourselves.	External R&D can create significant value; Internal R&D is needed to claim some portion of that value.
If we discover it first, we will get it to the market first.	We do not have to originate the research in order to profit from it.
If we are the first to commercialize an innovation, we will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property (IP) so that our competitors do not profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

In summary, Chesbrough (2006) states that only a small portion of innovations created under a closed innovation system actually make it from development to market. He also emphasizes that an Open Innovation business model offers greater possibilities to market and generate revenue from R&D and innovations. For these reasons, he suggests that organizations, given the opportunity, test an Open Innovation project to determine if it fits their business model.

3. Sources of Knowledge

To take advantage of the Open Innovation model, R&D teams need to be continuously networking with external sources of knowledge, including universities and national laboratories, small start-ups, specialized manufacturers and wholesalers, individual inventors and even retired technical staff and graduate students. Chesbrough (2006) states that Rosenberg and Steinmueller (1988) and Von Hippel (1988) independently identified four external sources of knowledge: (1) suppliers and customers, (2) universities and government, (3) competitors, (4) other nations. Organizations should train their employees in competitive intelligence gathering practices in order to have them constantly scan the business environment and input data into a database, which can be mined for useful information and analyzed for trends at a later date.

In the past, an organization's intellectual property was considered a consequence of internal R&D and innovation. The principles behind Open Innovation allow organizations to actively take a role in managing their intellectual property. However, if organizations are to adopt an Open Innovation model, they need to implement policies and procedures for researchers to organize and administrate the inflow and outflow of intellectual property. Additionally, organizations have to build a network of alliances and intermediaries to facilitate the exchange of the intellectual property, even at times to donate it for future goodwill. Consequently, with Open Innovation, organizations contract with third parties to act as networking facilitators. These facilitators have the knowledge and tools to provide access to virtual marketplaces in order to facilitate the transfer or the acquisition of intellectual property and/or inventions. Also, if required, facilitators have the means to transfer funds or provide financing so that transactions can occur. Examples of intermediaries for the pharmaceutical industry are *InnoCentive.com* and *Yet2.com*. For emerging industries, *NineSigma* and *YourEncore* are the paramount intermediaries as mentioned earlier.

Large organizations generally conduct basic research with their own money. This enhances their ability to take advantage of external knowledge. However, smaller firms or those specializing in research must find other avenues to network in order to acquire or transfer intellectual property. One method is to form a partnership with a university and

work within the university system to find marketable solutions to real problems. Intel still sets up its research laboratories near top research universities to take advantage of the open flow of information. Intel also recruits and hires academic researchers who have worked on their research to see their technology through production to commercialization. However, if organizations do not have the ability to exploit their intellectual property because they lack the capital or the intellectual means to take an invention from development to market, they may utilize a strategic alliance through a network to exploit their property. Chesbrough, citing Dyer (1996), describes the benefits of networked strategic alliances between Japanese automotive firms and the companies that sell components or services to them. Dyer (1996) found that the Japanese auto industry forms alliances (Keiretsu) that changed how they acquired new technologies from mostly purchasing them externally to developing or sourcing technologies from within their Keiretsu. Other research indicates that the rise of intermediate markets in some industries, for example in the auto industry, may alter the conditions for mode of entry and the incentives for new technology and innovation in general (Arora, Fosfuri, & Gambardella, 2001).

4. Open Innovation in R&D

Today, organizations are more willing to radically change their business model in order to innovate and develop technologies they can commercialize. At any time, they may experiment with Open Innovation to further their objectives.

However, Open Innovation manifests itself differently during each R&D phase:

- The Discovery Phase involves activities such as "creation, recognition, elaboration and articulation of opportunities." It also includes "basic research, internal hunting, external hunting/licensing, purchasing, investing" (Chesbrough, 2006, p. 69).
- The Incubation Phase involves "evolving the opportunity into a business proposition, including technical market learning, market creation and strategic domain" (Chesbrough, 2006, p. 69).
- The Acceleration Phase involves commercialization and developing and growing the business itself.

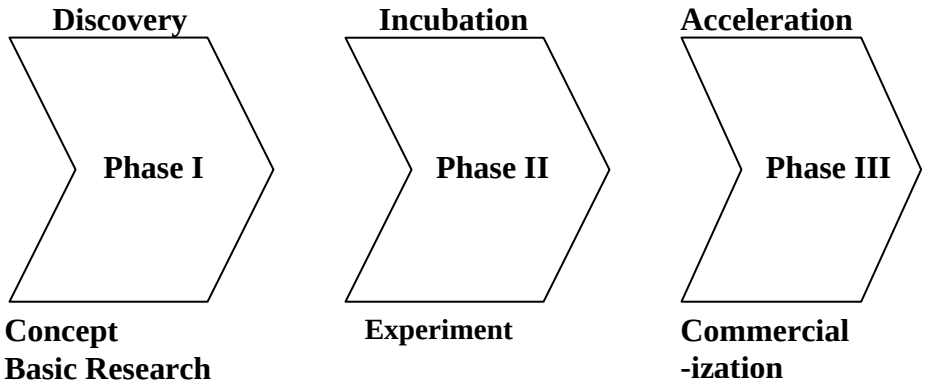

Figure 3. Phases of Research and Development.
From (O'Connor, 2006)

a. Discovery Phase

There is strong evidence of Open Innovation during the discovery phase. In the discovery phase, an organization looks within and outside for commercial opportunities. Organizations seek to reduce risk through quick and cheap learning. For instance, an organization's research staff can be active in a university or research center in order to stay abreast of new discoveries that have the potential for commercialization. Another method of gathering information includes external teams devoted to future trend analysis who visit laboratories working on exploratory research and identify business opportunities. Other organizations hire outside consultants who conduct market research or identify internal and external innovation. Consultants run idea generation workshops, and organizations can set up informal industry networks to brainstorm wild ideas. Larger firms go so far as to acquire small businesses and hire the former owners as internal entrepreneurs because of their experience in start-ups and managing a small and nimble organization. Organizations may even discover they lack the expertise needed to augment their limited experience with relevant partnerships such as joint ventures or subcontractors.

b. Incubation Phase

According to O'Connor (2006), during the incubation phase, there is a strong link between technological innovation and commercialization. Therefore, in this phase, there is a need to build businesses and markets in line with the company's strategic interest since any new technological development can threaten or alter a company's business model. At this point, organizations need to determine how well their invention fits their business strategy, and, if necessary, adapt their current strategy.

c. Acceleration Phase

O'Connor does not see Open Innovation as pertinent during this phase.

5. Managerial Challenges

West and Gallagher (2006) state that managers leading firms with an Open Innovation business model have to solve these problems:

- Maximizing the revenue stream from internal innovation by optimizing the mix of in-house product commercialization and making internal IP available to the general public for free or fee.
- Identifying appropriate external innovations and integrating them into successful products.
- Maintaining and stimulating a continuous supply of external innovations for integration into commercial products.

6. Intellectual Property Within an Open Innovation Framework

Chesbrough (2003) describes Open Innovation as a business model that assumes firms can, and should, use external ideas and paths to explore new markets. Open Innovation and open standard business models both refer to processes that involve sharing and exchanging technology and knowledge across organizational boundaries. The open standard business models profit from the commercialization of intellectual property, which takes place in a setting of either open or closed standards.

The term intellectual property encompasses patents, trademarks and copyright protection. However, for the purpose of this report, the focus is on patents. Patents give

inventors or organizations the right to exclude others from using their invention or intellectual property. The patent system generates incentives for innovation by producing a legal framework for protecting intellectual property and providing a business model for selling inputs, which creates rent-seeking behaviors.

Over the years, the model for controlling intellectual property supported by most businesses and the government has been a closed standard. A closed intellectual property strategy calls for the licensing one or more patents, normally with very strong rights of control. The closed standard protects an organization's product innovation from its conception and for the next 14 to 20 years, depending on the type of patent. Closed business strategies seek to control intellectual property to capture a share of the value for revenue generation such as licensing or through a hold-up. A hold-up occurs when an organization knows that a commercial product that violates their patent rights will be released. However, the patent owner only approaches the other company about their patent infringement after the technology is successful, in order to then ask for huge sums for compensation. However, the closed model holds innovative product concepts close, sometimes to the detriment of the organization because organizations often lack the funding or knowledge to commercialize their intellectual property.

7. Open Business Strategies in Managing Intellectual Property

Today, there is a shift from the closed toward a more open business model. Open business models are characterized by different strategies and institutional arrangements such as venture capital, start-ups, spinouts and proactive licensing of intellectual property. Open business strategies encourage value by making the underlying technology available to others. Open strategies are transparent, which is not the case with closed strategies.

Historically, closed organizations gathered, hoarded and filed their intellectual property. For example, patents often only provide design freedom to local internal staff. Even other divisions within the same company are often not aware of the intellectual property and cannot commercialize or benefit from it in any meaningful way. The closed system of protecting intellectual property often results in costly litigation due to patent

right infringements. In addition, the closed system traps spillover technology generated from basic research within organizations, limiting opportunities to generate value from it. Therefore, organizations with a closed innovation system often find that if their research creates spillover technology that falls outside of their business model, they do not have the internal resources to capitalize on it. In some cases, spillover intellectual property is licensed, but more often than not it is filed and awaits internal development, often in vain. Yet, intellectual property is worth little if it is never used. Within an Open Innovation business model, intellectual property becomes an asset that is managed as a possible source of revenue. It points toward future business opportunities or a future business model. Open Innovation provides a rational reason why organizations should be active buyers and sellers of intellectual property.

Intellectual property plays a special role in an open innovative business environment. An open business model tears down vertical product integration, especially in R&D. A number of organizations such as IBM, P&G and Ely Lilly now disclose some of their intellectual property and make it available for free. Organizations anticipate that giving away their base technology will improve their standard's odds for success in the marketplace. Occasionally, a number of organizations contribute to a royalty-free patent pool in order to overcome problems associated with the coordination and collection of intellectual property needed to implement a standard. This challenge was demonstrated during the development of the Ethernet protocol. Ethernet is a family of networking technologies that allow computers to talk to one another across a network. In the early 1980s there were three systems competing to become the local area network (LAN) technology standard. The first was supported by the Institute of Electrical and Electronics Engineers (IEEE) and called the IEEE 802; the second was supported by Intel, DEC and Xerox and called "Blue Book" CSMA/CD; and the third system was supported by IBM and Token Bus and called Token Ring. It was not until 1984 that supporters of all three groups got together with the European International Electrotechnical Commission and decided on a hybrid system called the International Standard ISO/IEEE 802/3. Now LAN cards and software in almost any computer can communicate with each other seamlessly. The cable modem protocol is another example of competing organizations combining

their resources into a patent pool in order to guarantee access and lower search and transaction costs for themselves. Cooperation on standards and patent pools not only save money for the manufacturers but, ultimately, the consumer as well.

An Open Source licensing business model with royalty-free patent pools limits the implementers' ability to develop proprietary patents based on intellectual property from the patent pool. Additionally, some licensing arrangements inherent in patent pools grant forward provisions. Therefore, any technology using a royalty-free patent as a starting point for development cannot tie the royalty-free patent to a new patent that is licensed for a fee. As a result, all patents derived from the original royalty-free patent must also become royalty free, which essentially makes openness a self-sustaining feature of the technology.

Another method to protect an organization's intellectual property is called a disclosure strategy. This strategy used by a single company that discloses its intellectual property to discourage or protect against the adoption of a new standard that might arise from competitors to its own patents. A company will freely release its intellectual property in hopes that the technology becomes the industry standard and is copied by smaller firms. This method is used by Cisco Systems, Inc. (Cisco) to protect its router business. Cisco differentiates its business model by providing higher quality products and better service. Therefore, Cisco is not competing on the basis of its router patent.

8. Standard Setting Organizations (SSO)

Open Innovation standards offer forums wherein organizations voluntarily collaborate on design and promotion of potential new standards. The openness of the group increases the probability of coordination among participants. Proponents of the Open Innovation model work toward creating a legal framework to support the free marketing of their products and to make it impossible for non-affiliated firms to capture value through IP licensing.

Anticipatory standard setting is a business model that attempts to create standards ahead of the market. Standard Setting Organizations (SSO) collect a body of established patents and copyrights from interested companies to prevent companies from joining the

organization just for the right to opportunistically use the patents available to the organization without contributing. A SSO business model runs more smoothly because standards are set without the pressure of impending commercialization. However, setting up an SSO requires a great deal of insight and foresight.

In order to strike a balance between the collective benefit of high quality standards and the legitimate interest of participating companies with patents, SSOs manage and oversee the negotiations for intellectual property licensing. However, time and again competing SSOs end up designing similar products, which results in an intense competition for a single dominant design or technology as the standard. The most intense competition is observed between SSOs trying to market competing technologies to the same customers. Examples of such intense competition were seen when the VHS format competed against Beta Max to become the dominant VCR standard format. This fierce competition was also seen when Windows competed against Apple to become the dominant personal computer operating system, and when Internet Explorer competed against Netscape to become the paramount Internet browser.

Firms participating in SSOs hope to capture some of the value associated with the general acceptance of the new standard. In the past, firms that supported closed specifications had the potential to capture a larger share of a closed market. Alternatively, organizations using open specifications capture a smaller share of a much larger market. This happens because closed specifications constrain the size of the market, whereas open specifications allow the market to expand more rapidly.

9. Roles of Standard Setting Organizations (SSO)

Organizational charters and bylaws govern SSO rules and procedures. Joining is obligatory if participants wish to benefit from the organization's pooled intellectual property. SSOs provide their participants three types of services: search of pooled intellectual property and patents, a means to disclose the participants' intellectual property and patents, and a legal framework in which they can license their intellectual property and patents. SSOs also work to protect their participants by advising them against adopting standards that expose them to a single participant patent holder wanting

to change the licensing terms on the agreement. For example, predatory firms purchase smaller firms for their intellectual property in the anticipation that this firm's intellectual property is adopted as a component within a standard or product. The predatory firm then has the power to demand a royalty or fee for the use of the intellectual property from the other participants working on the standard. This tactic is often used after other participants of the standard group have already begun to incur considerable expenses designing products with this standard.

Working within their charter, SSOs ensure the openness of their standards. They do this through licensing rules that restrict privileged terms and conditions sought by powerful participants. The SSO reduces their participants' risk by removing worries about pending patent applications and possible infringement on their intellectual property. A brief description of the two major types of licensing rules follows:

a. *Limited Licensing Arrangements*: The most popular type is a reasonable and non-discriminatory limited licensing arrangement. Depending on the bylaws of the SSO's charter, this method is vague, but generally holders cannot refuse to grant a license and are given wide latitude to set prices according to their license.

b. *Royalty-Free License*: This type of license requires participants to grant a royalty-free license to all members of the SSO. Additionally, the SSO's charter requires the patent holders to assign their intellectual property to the SSO.

c. *Other*: Licensing rules are not restricted to just the types outlined above. Depending on the technology, the market and the organizational structure of the SSO patent holders influence the structure of the SSO's charter and the role it plays in marketing the standards.

10. Recognized Problems

Voluntary non-market SSOs has no legal authority and little or no power to enforce standards under their control. Further, Farrell and Saloner's (1988) standard model concludes that while markets are faster at choosing one design over another,

committees are more likely to coordinate a single compatibility standard. Therefore, successful SSOs operate well where high levels of coordination are required such as the International Telecommunications Union (ITC) and the Institute for Electrical and Electronic Engineering (IEEE). Both have practiced collaborative innovation for over 100 years.

Standards impact the engineering and design of new technology by how a standard is applied in a new product. Moreover, the impact standards have on the relative value of substitutes influences the value of that alternative technology. Therefore, a standard only produces value for its developers if it is compatible with commercial products and the SSO is able to coordinate interoperability and commercial acceptance in the marketplace. Also, the standard and the value it brings to a product are much enhanced by the product features that are designed by marketing beyond the original intellectual property. For example, the standards for MP3 players and the cell phone standards 2G and 3G have the same underlying technology functions on all products using the standard, but consumers only see the product features that differentiate one product from another.

a. Downside of an SSO

An unscrupulous business strategy sometimes practiced by few participants in a SSO is to wait for implementation of a standard before informing the SSO of their ownership of prior patents in order to demand royalties. This is the hold-up strategy mentioned earlier. Organizations practicing this behavior know the high cost of switching technologies, and demand a user fee for a license or rent for their patent.

Open Innovation and SSOs face competition from other intellectual property business models. Therefore, it is important for an organization to recognize the potential cost associated with their intellectual property strategies. Organizations commit to specific investments because large switching costs are associated with integrating a new standard into a process or product. For this reason, organizations seek the protection offered by a SSO to limit the uncertainty over possible legal disputes after the standard has been integrated into their product. However, SSOs can be distracted by the

overwhelming quantity and the questionable quality of intellectual property in their standard patent pools. Moreover, this committee driven approach can cause long delays in setting a standard, and competing models might beat the standard to market, thereby gaining first mover advantages. Furthermore, in collaborative design committees there is a free rider problem, when a participating firm adds little to the collective knowledge base, but is still free to use the standard in its products once the project is complete. Within this cooperative business environment, another business model emerged, in which an organization's sole purpose is to acquire intellectual property and patents. These patent trolls specialize in acquiring patents mainly for litigation purposes.

As an organization becomes more specialized because they adopted an Open Innovation business model, they often eliminate their manufacturing capacity so that they can focus more on managing their intellectual property and their ability to cooperate in setting standards and implementing them in order to generate revenue.

11. Summary

Henry Chesbrough in Open Innovation (2006) describes this practice as a new resource for R&D and an innovative business model that takes advantage of internal and external sources for information ideas and new markets. Chesbrough (2006) *also* explores how Open Innovation affects a number of management subjects such as general management, new product development, industrial engineering, managing innovation, entrepreneurship and managing intellectual property. Chesbrough (2006) and his co-authors use real-world examples to frame problems that businesses will encounter when they conduct an Open Innovation test study and how established management practices need to change. An organization, for example, may have to freely offer its intellectual property before others will offer theirs. Rather than pushing a product onto the market, the principles of Open Innovation cause organizations to work more closely with their customers in order to provide what customers want.

Chesbrough (2006) makes the assertion that the products we use everyday are becoming more and more complex as time passes. Thus, as system designs become more complex, no one person or even organization can manage the technology alone.

Therefore, they must recruit a diversified team of subject experts to help innovate and market their products. The time of the great American inventor spending decades working along in a lab on a breakthrough category killer has passed.

Chesbrough (2006) also states that the smartest people often do not work for a parent organization, and for this reason, that organization must build networks, both external and internal, to create a reservoir of ideas in a databank. The challenge then becomes for organizations to devise methods, formulate procedures, and enact policy to mine the databank for useful knowledge and marketable innovations as well as to have the courage to create joint projects with competitors and seek opportunities in places where they never existed yesterday. According to Chesbrough (2006) some companies are better at managing this change than others.

Open Innovation strategies are transparent, which is not the case with closed strategies. An open business model tears down vertical product integration, especially in organizations that conduct R&D. Managers thinking of adopting an Open Innovation business model will have to solve a number of inherent problems for example:

- managing innovation by optimizing the mix of in-house product commercialization,
- allowing the general public to view internal IP and consent to its free or for fee use,
- identifying external innovations that match an organization's core business and integrating them into marketable products, and
- maintaining and stimulating a continuous stream of external innovations for integration into commercial products.

Open business strategies enhance value by making the underlying technology available to others.

Chesbrough (2006) sees successful organizational management of Open Innovation as a competitive advantage to an organization or industry. He explains that few organizations have the resources in terms of internal knowledge, and long-term financing to launch a R&D project into a successful commercial product. Therefore, Chesbrough (2006) suggests identifying external sources for knowledge such as: (1)

suppliers and customers, (2) universities and government, (3) competitors and (4) other nations. Thus, as organizations replace their closed business model with an open business model, organizational networks will expand globally and continually seek new business relationships. In addition, organizations must train their employees how to collect competitive intelligence and input data into a database to store and later analyze the data.

The open business model is characterized by different business strategies and institutional arrangements. Organizations form short- or long-term temporary joint ventures to exchange or share resources with other organizations. An organization should consider a wide range of options to access resources such as venture capital, start-ups, spinouts and proactive licensing of intellectual property. Another business practice organization must consider is working toward creating standards ahead of the market by creating and joining Standard Setting Organizations (SSO). SSOs collect patents and copyrights to build a patent library. The patent library allows participating organizations to build a particular type of technology or to make others pay a royalty to access patents and technologies. However, SSOs must prevent organization from joining without supplying patents and other resources to eliminate opportunistic free-riders.

Intellectual property plays a special role in an Open Innovation business environment. Intellectual property becomes a commodity which, if managed correctly, can become a source of revenue as well as a tool to help build relationships. A number of organizations disclose some or all of their intellectual property and make it available for free. Organizations that provide their standards, patents or intellectual properties royalty free improve the odds for general acceptance in the marketplace and limit other organizations from developing proprietary patents based on intellectual property from the patent pool. This is known as a disclosure strategy. This strategy is used by organizations that disclose their intellectual property in order to discourage and protect their standard from competitors adopting it and incorporating it into a new patent.

Henry Chesbrough (2006) and his co-authors investigate the links and the practice of Open Innovation and have established a body of research into collaborative innovation that describes what's new and what's familiar in the process. *Open Innovation* explores the potential Open Innovation brings to organizations running R&D programs and gives

real world examples from Cisco, Ely Lilly, Linux, to P&G and Xerox who are now testing its possibilities and limitations. However, there is a lack of experienced Open Innovation practitioners with the talent required to design, implement and manage large scale complex programs.

The next section looks into whether or not people will volunteer to come together to virtually produce a new product and what pitfalls a manager might encounter.

D. THE WISDOM OF CROWDS

Author James Surowiecki in *The Wisdom of Crowds* (2005) analyzes sociological works on group decisions making and postulates how and why the statistical average of all answers obtained from each individual within a large group often comes closer to the best possible answer than the best answer of the most expert individual within the same group. He then investigates under which conditions a crowd of average individuals can achieve greater accuracy, and how this decision making strategy can be translated into better organizational outcomes.

1. Examples of Large Groups Making Smart Aggregate Decisions

The self-made man or woman is a cultural icon for most Americans. The rags-to-riches American dream is ingrained in us from an early age, when we were first taught about Benjamin Franklin growing up poor in Boston and becoming a scholar and statesman, to our modern cultural icons who represent our ideals of hard work and entrepreneurial spirit, such as Sylvester Stallone's movie production *Rocky*, Microsoft's founder Bill Gates and Oprah Winfrey, TV personality-commentator-actress-producer. These ideals are reinforced by our real life mythologies about Thomas Edison and the thousand attempts it took before he discovered that a tungsten filament can make a commercially acceptable light bulb or about Alexander Graham Bell's eureka moment when he invented the telephone. Therefore, our expectations can lead us to believe that a single exceptional person can rise from the masses and start the next industrial revolution or its modern day equivalent and save America.

However, the examples that Surowiecki (2004) gives assert that no single person has all answers and that a diverse group of non-expert people is better at problem solving than the most intelligent individual alone. Therefore, he concludes that if a group solves problems better than an individual, then a much larger group is even better at solving problems. He also sees the Internet as a communication tool that offers great possibilities to create virtual teams and to reorganize how teams solve problems. The rest of this section describes three situations where a group or team arrives at a better decision than individuals alone. This is the basis upon which Surowiecki (2004) forms his opinions.

a. Ox-Weight Decision

Surowiecki (2004) recounts a story of British scientist Francis Galton spending a day at a county fair in 1906. Although Galton went to the fair to study genetics, he ended up at a livestock weight-guessing competition: A prize was offered to the individual who could most accurately guess the weight of a certain ox after it had been slaughtered and dressed.

Galton observed that the crowd consisted of butchers and farmers, but also clerks and other individuals without expert knowledge of farming or butchering. Approximately 800 individual guesses were tallied. Galton collected the results from the contest operators, arranged them in numerical order and graphed them in a bell curve. He then calculated the mean of the guesses, theorizing that the average of averages would represent the very best guess.

Galton was surprised to find that a crowd made up of mostly ordinary people, with few true experts among them, was less than one pound off from the correct answer: The slaughtered weight was 1,197 lbs. while the crowd's guess was 1,198 lbs. Galton later wrote about the experiment: "The result seems more creditable to the trustworthiness of democratic judgment than might have been expected" (Surowiecki, 2004, p. XIII). He made a remarkable first observation hinting at the genius of crowds.

b. Who Wants to Be a Millionaire?

The television quiz program *Who Wants to Be a Millionaire?* provides a more current example of the intelligence of crowds. The show asks contestants to correctly answer 15 consecutive multiple-choice questions in order to win a million dollars. A contestant has three opportunities to ask for help in order to answer a question. The contestant can either: (a) reduce the number of choices from four to two, (b) telephone a person considered an "expert," or (c) poll the program's audience. In this setting, individual intelligence is regularly tested against group intelligence. Statistics of the show, however, determine that the "experts" know the correct answer only 65% of the time, while the crowd has the correct answer 91% of the time (Surowiecki, 2004, p. 4). Therefore, this reinforces Surowiecki's theory of the intelligence within crowds.

c. Location of the Scorpion

Surowiecki (2004) recounts the story of the disappearance and search for the submarine USS Scorpion as told in *Blind Man's Bluff: The Untold Story of American Submarine Espionage* (Sherry Sontag, Christopher Drew and Annette Lawrence Drew, 1998) as a further example: The submarine USS Scorpion sank somewhere in the North Atlantic around May 20, 1968. The Navy had little idea where to look for it and put together a team of experts from diverse professions, including mathematicians, submarine specialists and salvage experts. The team was lead by Dr. John Craven, Chief Scientist of the U.S. Navy's Special Projects Division. Craven and his team started by determining a series of possible scenarios that could have led to the submarine's disappearance. Instead of asking his experts to relate their best guesses to one another, he asked each one individually to comment on the likelihood of each scenario. Craven then created a competition in which each team member submitted his best guess on why the submarine ran into trouble, on its speed, on its direction, its steepness of decent, etc.

Under Craven's direction, the team reviewed all guesses and, based on the average of the aggregate results, put together a composite picture of what happened to the Scorpion and its final location. Craven employed novel statistical methods (Bayesian search theory) in order to develop an estimate of the submarine's location. Thus, five

months after the USS Scorpion vanished, the Navy found it less than 220 yards from the location Craven calculated from the averages of estimates (Surowiecki, 2004, pp. XX–XXI).

2. Prerequisites for Making Smart Aggregate Decisions Through Large Groups

Surowiecki (2004) identified four conditions that must be present for crowds to make optimal decisions. The four conditions are (a) diversity of opinion, (b) independence of participants, (c) decentralization and (d) aggregation (Surowiecki, 2004).

a. Diversity of Opinion

Diverse teams or groups perform best when each person depends only on the information they collect by themselves, and members of the group cannot consult with each other and share their information. When Surowiecki (2004) addresses diversity, he is not referring to participants' age, race or creed, but he is referring to each team member's level of training and specialization. Surowiecki (2004) is of the opinion that the best teams have a broad (or diverse) range of experience, skill sets and areas of expertise.

Team decision making becomes less accurate when the knowledge within a group becomes homogeneous. This happens when group members formulate their opinions using the same sources of information. Surowiecki (2004) states that diverse groups attain greater perspective, expand the possible set of solutions, and encourage more innovative or novel solutions to problems (Surowiecki, 2004).

Homogeneous groups, according to Surowiecki (2004), are less able (or willing) to consider and investigate alternatives and may suffer from "group think." Homogeneous teams and small groups sometimes are more willing to create and sustain consensus rather than invite dissent. Therefore, they may be less willing to seek information that conflicts with group opinions and emphasize information that supports their consensus (Frey, Kerschreiter, Mojzisch, Schultz-Hardt, 2008).

Surowiecki (2004) quotes organizational theorist James G. March: “The development of knowledge may depend on maintaining an influx of the naïve and the ignorant... competitive victory does not reliably go to the properly educated” (Surowiecki, 2004, p. 31). It can be inferred from this statement that the addition of less experienced team members, or those with different backgrounds or areas of expertise, can actually make groups act more intelligently. “Expert” teams frequently overestimate their knowledge and often make decisions that are neither consistent with other experts outside of their group nor consistent with their own previous research (Shanteau, 2000). Shanteau supports his findings with a study that found that physicians given the same set of symptoms in several scenarios gave consistent answers only 50% of the time (Shanteau, 2000). In addition, Surowiecki cites economist Terrance Odean, who “found in his research that physicians, nurses, lawyers, engineers, entrepreneurs and investment bankers, believe that they know more than they objectively actually do know” (Surowiecki, 2004, p. 34). Therefore, Surowiecki (2004) assumes that experts are more likely to overestimate their knowledge and the probability of having the correct answer. Supporting this theory, Surowiecki (2004) points out that between 1984 and 1999 the vast majority (80–90%) of mutual fund managers underperformed the Wilshire 5000 index (Surowiecki, 2004, p. 33). By comparison, a capital equity group called Marketocracy Capital Management manages the Marketocracy m100 Index, which they describe is an aggregate of the top 100 portfolios out of 100,000 model portfolios. In 2009 Marketocracy reported that fund has beaten the S&P 500 Index in 8 of the 11 quarters since inception November 2001 (Marketocracy.com, 2009).

To ensure that organizational leaders set up diverse teams, Surowiecki (2004) recommends that they rotate in new team members with different skill sets or assign team members with less experience and fewer capabilities to the group. This does not mean that teams only consists of amateurs; rather organizations must recognize that a “crowd” or cross functional team can find a more practical solution than one or two experts.

b. Independence of Participants from Each Other

People must form their own opinions without being influenced by their peers within the group. The participants' independence is important for two reasons: First, it keeps mistakes an individual makes from infiltrating and penetrating into the group's beliefs. Thus, errors made by individuals do not corrupt the group's collective judgment. Secondly, individuals learning independently are more likely to contribute new information to the group rather than relying on the same data everyone else is familiar with. Surowiecki (2004) states that individuals can be biased and irrational, but as long as each member in the group remains independent, a single individual will not make the group's decision less accurate (Surowiecki, 2004). If members within the group do not retain their independence, the group can fall victim to what Surowiecki (2004) calls the "herding effect" (Surowiecki, 2004, p. 49). The herding effect becomes evident when group members, who share similar training, values and culture, follow the safest strategy in order to avoid the risk of public failure or humiliation. A similar problem, which Surowiecki (2004) calls the "information cascade," occurs when information is so pervasive within a group that it is viewed as common knowledge and is therefore not questioned (Surowiecki, 2004, p. 54).

Therefore, choosing an answer consistent with "common knowledge" seems like the best and safest decision to most group members. This effect is exemplified in "financial bubbles," for instance the most recent correction in the real estate and mortgage market. This effect is exemplified when a financial market takes an upward swing and the value of this market grows faster than the rest of the market and buyers rush into a market. A common heuristic in the United States recommends buying a house because the value of a home will never go down. However, from 2006 to 2009 housing prices fell across the country. Another familiar misnomer recommends the purchase of gold because it has real value. Consumers who purchase gold bullion as an investment believe that the value of gold remains consistent. However, if demand for bullion falls, or recycling becomes more efficient, or if a new mine starts to produce large volumes, the value and the price of gold bullion will fall (Martchev, 2009). Economist Hans Sennholz (2003) states that in "desperate situations people may prefer a pound of bread to an ounce

of gold, essential clothing and shelter to a pound of gold … when their lives are at risk" (Sennholz, 2003). Therefore, Surowiecki (2004) warns against using common knowledge as a foundation for formulating an opinion.

Surowiecki (2004) recommends that organizations form smart groups by seeking members with diverse perspectives and opinions that remain independent of each other. Team formulation is discussed later in the report.

c. Decentralization

People are able to specialize and draw on personal knowledge and local research. For example, biologists and physicists who work independently are increasingly using the Internet to join like-minded colleagues in self-organized decentralized research collectives (Surowiecki, 2004). A search of Linked In©, an online network for professionals similar to MySpace®, describes 30 discussion groups for biologist, and another 25 groups for physicists (LinkedIn.com, 2009). Surowiecki (2004) explains the reason behind this new development is that scientific subject-matter research has become so complex that in order to reach a solution, each member of a research team only solves a small piece of a much larger problem. This process provides checks and balances since researchers collaborate to verify results and perform peer reviews before publication. Occasionally, this collective work environment is typified by hundreds of scientists referenced as authors of a biochemist or life sciences report. The European Geophysical Society, for example, published a research study in 2001 called *First Multispacecraft Ion Measurements In and Near the Earth's Magnetosphere with the Identical Cluster Ion Spectrometry (CIS) Experiment"* (Rème et.al., 2001). This study references 78 researchers from eighteen separate locations and three different continents. Below is the report's actual biographical reference:

H. R`eme1, C. Aoustin1, J. M. Bosqued1, I. Dandouras1, B. Lavraud1, J. A. Sauvaud1, A. Barthe1, J. Bouyssou1, Th. Camus1, O. Coeur-Joly1, A. Cros1, J. Cuvilo1, F. Ducay1, Y. Garbarowitz1, J. L. Medale1, E. Penou1, H. Perrier1, D. Romefort1, J. Rouzaud1, C. Vallat1, D. Alcayd´e1, C. Jacquey1, C. Mazelle1, C. d'Uston1, E. M¨obius2, L. M. Kistler2, K. Crocker2, M. Granoff2, C. Mouikis2, M. Popecki2, M. Vosbury2, B. Klecker3, D. Hovestadt3, H. Kucharek3, E. Kuenneth3, G. Paschmann3, M. Scholer3, N. Sckopke (†)3, E. Seidenschwang3, C.W. Carlson4, D.W. Curtis4, C. Ingraham4, R. P. Lin4, J. P. McFadden4, G. K. Parks4, T. Phan4, V. Formisano5, E. Amata5, M. B. Bavassano-Cattaneo5, P. Baldetti5, R. Bruno5, G. Chionchio5, A. Di Lellis5, M. F. Marcucci5, G. Pallocchia5, A. Korth6, P.W. Daly6, B. Graeve6, H. Rosenbauer6, V. Vasyliunas6, M. McCarthy7, M.Wilber7, L. Eliasson8, R. Lundin8, S. Olsen8, E. G. Shelley9, S. Fuselier9, A. G. Ghielmetti9,W. Lennartsson9, C. P. Escoubet10, H. Balsiger11, R. Friedel12, J-B. Cao13, R. A. Kovrazhkin14, I. Papamastorakis15, R. Pellat16, J. Scudder17, and B. Sonnerup18 (2001) *First multispacecraft ion measurements in and near the Earth's magnetosphere with the identical Cluster ion spectrometry (CIS) experiment*,-- 1. CESR, BP 4346, 31028 Toulouse Cedex 4, France // 2. UNH, Durham, USA// 3. MPE, Garching, Germany// 4. SSL, Berkeley, USA// 5. IFSI, Roma, Italy// 6. MPAE, Lindau, Germany// 7. U. W., Seattle, USA// 8. IRF, Kiruna, Sweden // 9. Lockheed, Palo Alto, USA// 10. ESA/ESTEC, Noordwijk, the Netherlands// 11. Bern University, Bern, Switzerland// 12. Los Alamos National Laboratory NM, USA// 13. CCSAR, Beijing, China// 14. IKI, Moscow, Russia// 15. University of Crete, Greece// 16. Commissariat `a l'Energie Atomique, Paris, France// 17. University of Iowa, USA// 18. Dartmouth College, NH, USA -- Annales Geophysicae (2001) 19: 1303–1354 c European Geophysical Society 2001, Received: 13 April 2001 – Revised: 13 July 2001 – Accepted: 16 July 2001. Retrieved March 9, 2009 from: http://sprg.ssl.berkeley.edu/adminstuff/webpubs/2001_ag_1303.pdf

Additionally, the Life Science Grid (LSG) and the European Bioinformatics Institute (EBI) are examples of non-profit organizations, InnoCentive and NineSigma of for profit organizations that bring professionals together to collaborate on research programs. These organizations are described in greater detail in previous chapters.

Peters and Waterman states in *In Search of Excellence* (1982) that rigid hierarchical organizations with multiple management layers inhibit the free flow of information from frontline personnel up the chain of command to higher level management. Surowiecki (2004) states that top-down organizational structures cause employees to hide information to avoid accountability. Surowiecki (2004) recommends that an organization's management would benefit more by delegating decision-making power down the chain of command, where the employees closest to and most familiar with a particular problem are empowered to find and implement a solution (Surowiecki, 2004). The reason for this shift in power is because front-line employees have specialized knowledge in their local area and are best suited to find the most practical and most efficient solutions. Such decentralization of organizational power motivates local management and employees to become more engaged in their work. This makes coordination and collaboration smoother, since employees are free to explore more

efficient methods to complete their tasks. Since decentralization heightens employees' sense of responsibility, it allows managers to minimize micromanagement, which creates time for them to focus on more important organizational tasks.

Surowiecki (2004) states that decentralization of teams encourages independent learning and research as well as specialization of individuals while keeping each participant motivated to cooperate and collaborate as a group to solve difficult problems.

d. Aggregation

Aggregation implies collecting data from multiple sources and recombining it into a set of possible outcomes or into a new concept, which provide greater value than the sum of all data points prior to aggregation. A set of possible outcomes is created when stock traders aggregate such diverse information such as: the prices of raw materials, the unemployment rate, the price of gasoline and changes in federal legislation and regulations, to determine fluctuations of stock prices and industries. The stock trader's customers are interested in the range of possible prices for each company in that industry such as automotive, mining, energy. A new concept is created when a TV station combines the weather conditions with the time of day and the location of a truck accident to determine that there will be a traffic jam on the highway at 4:40 pm and e-mails this information to people who signed up for local news reports on the station's Web site. People can then decide to leave the office earlier or later than usual to avoid sitting in traffic. Therefore, for aggregation to occur, a team creates a means of gathering data points and recombining (or aggregating) them into useful information that has a far greater value than the sum of data.

In terms of Crowdsourcing, data collected for free from the general public or a large group can be combined with other data and is then reconfigured into a product that offers value to the public or to a select group. Generally, the value of the input is worth less than the value of the output, which provides the incentive to the public to continue supplying new data. Sometimes aggregation is mistaken for consensus building,

but the examples show that this not the case. It really is about the value of information. As soon as the output becomes less valuable to the user than the input, the continuous flow of input data will cease.

Therefore, an organization interested in Crowdsourcing must devise a mechanism to collects low cost data, combine it with other data and then either reconfigure it into a product or into a collective decision. In addition, organizational mechanisms may take the form of mathematical or statistical software routines that analyze data and aggregate it into an average of averages in order to determine the optimal collective solution. This averaging process was used by Dr. John Craven in locating the USS Scorpion, but specialized software allows an organization to combine a much greater amount of data and give users a statically significant answer to any question.

3. Decision Making

Surowiecki (2004) states that groups or "crowds" of self-interested individuals, each working independently on the same problem, will likely arrive at the best aggregate solution. However, Surowiecki (2004) does not explain how self-organized decentralized groups or teams get together and make a decision. Group decision making usually requires collective consensus rather than compromise. If a minority is opposed to a set course of actions, the group will meet until all objections have been modified and all objectionable features are removed. However, if this proves impossible, a consensus does not require all individuals, but a majority of individuals, in a group to agree to a course of action. Jeff Howe in Crowdsourcing (2008) breaks down decision making into three styles: predictive and distributive problem solving and brainstorming.

a. Predictive Problem Solving

Prediction is a forecast of the probability that an event will happen under specific circumstances. Thus, predictive decision making asks the members of a crowd to vote the best course of action, which eliminates avenues that should not be pursued further. Voting continues until there is agreement on one course of action only.

b. Distributive Problem Solving

Distributive problem solving is applied to the most complex problems or projects, when a problem is broken down into ever smaller sub-problems or nodes, and each one is distributed to a team to solve. This allows for nodes to be solved concurrently rather than sequentially and to be assembled at a later time. Teams can receive awards according to the amount of nodes they solve. An award can be financial or a higher ranking over other teams for bragging rights. A final award is often given for the most efficient assemblage of the project.

c. Brainstorming

Brainstorming allows everyone in the group to be an equal in the process. Brainstorming is used to create a list of solutions, rank them or vote on them, and to determine which courses of action require further investigation and research. Brainstorming has its advocates and opponents. Some argue that brainstorming is not productive enough, especially in an online forum (Barki, Gallupe, Hoppen & Pinsonneault, 1999). However, others argue that large groups generate more unique and higher quality ideas and group participants are more satisfied with online than face-to-face groups (Bastianutti, Cooper, Dennis, Gallupe, Nunamaker & Valacich, 1992). Advocates predict that online brainstorming will be able to overcome some of the inherent shortcomings of brainstorming sessions, such as evaluation apprehension.

John Gastil and Peter Levine, editors of the *Deliberative Democracy Handbook: Strategies for Effective Civic Engagement in the Twenty-First Century* (2005) offer advice on conducting online deliberations or discussions. Deliberations and considerations are meant to look at all sides of an issue to determine the reasons supporting or obstructing a solution. A project manager establishes an online community that practices together interactive e-learning, online research, holding or monitoring group discussions, forums and chat. These activities are followed by online polling and computer-mediated communication and group decision making that utilizes collaborative software .

More complex problems consisting of multi-variable conditions require the help of a Group Decision Support System (GDSS). A GDSS is a computer supported evaluation system designed for a collaborative work environment. Collaboration is accomplished either through a common computer or across a network. Variables are assigned preferences and weights. Each proposed solution is then evaluated according to given criteria and fit. After all the variables are entered into the system, the computer runs a series of statistical algorithms representing the variables to determine the best solution.

Joe O'Halloran, the projects editor for Computer Weekly, validates the significance of GDSS in his August 2009 article, "The Business Benefits of Web 2.0 and Collaboration Technology. O'Halloran (2009) claims that collaborative decision making technology, (i.e., software and business processes can help optimize decision making, leading to higher productivity, better communication with and between suppliers and improved customer service and profitability) (O'Halloran, 2009). He also predicts that organizations practicing collaborative decision making become more flexible, share knowledge within their network more effectively, react faster, and produce more effective supply chains (O'Halloran, 2009).

4. Overcoming Limitations of Group Behaviors

A prominent historical example of the worst outcome of group dynamics is the "Bay of Pigs" fiasco in the 1960s. The group dynamics at play in President Kennedy's team when they were planning the invasion of Cuba are now known as "Groupthink." This term was first used in an article written by William Whyte in 1952, but it was made famous by Irving Janis in the 1970s, when he conducted research on this subject, especially in political environments. Groups that suffer from groupthink were found to emphasize research that supports their point of view and to discount information that does not. Groupthink severely limits the effectiveness of a group by valuing group consensus over team members expressing their opinions. This practice allows peer pressure to cloud individual judgment and to suppress opposing viewpoints, which prevents the evaluation of alternative actions. Members of President Kennedy's team felt

that dissent was no longer a safe consideration because of its negative effect on group cohesion and the concern that arguing would delay the invasion date and increase the risk of Cuba discovering the invasion, which caused intelligent individuals to support a foolish enterprise that was doomed before its start.

High performing teams are becoming ever more important because every organization's products are increasing in complexity, and more and more companies are doing business globally. Jon Katzenberg and Douglas Smith, authors of *The Wisdom of Teams* (1993), found that if organizations have no understanding of team development, their teams will not reach their full potential (Katzenberg & Smith, 1993). They suggest that first, managers and business leaders need to understand that each group, even a small group, has an identity and a dynamic of its own. Even individual contributors share an organization's norms, values and culture. Organizations must learn how organizational beliefs, norms and culture affect group behavior and limit or enhance teamwork in both large and small groups. Most often, organizational incentive systems reward individual rather team contributions. If teamwork is key to an organization's success, then the incentive structure needs to reflect this. However, management needs to critically evaluate if a team structure furthers its mission and fits the organization's strategy and structure or not.

In a strictly hierarchical organization, the team leader is normally selected based on rank and / or seniority. Janis pointed out in his research that several of Kennedy's advisors approached him on a personal basis to express their concern with the plan. While Kennedy listened, he did not formally acknowledge their worries, nor did he offer to discuss them during planning meetings. Because of the organization's cultural norms that existed in Kennedy's team at that time and his position within the group as the leader, he exerted undue influence over the other team members and their judgment. This effect is especially true when team members have no interest in their project and no stake in its outcome. Under such circumstances, the team often cedes control over the agenda, the discussion and the final decision instead making the effort to contribute.

Katzenberg and Smith (1993) state that in order to build a high performing team, team members need to know their role, their responsibilities and their obligation to share

their findings with stakeholders in their cross matrix organization. Since a hierarchical structure can limit an individual's willingness to voice their independent judgment, Katzenberg and Smith (1993) suggest that for organizations to have high performing teams they have to flatten the hierarchy and set well defined goals. Their team members need to remain independent and encourage each other to give honest feedback. Such teams also have a framework to enforce accountability, handle conflict and address divisive issues (Katzenberg & Smith, 1993).

Surowiecki (2004) states that "group deliberations are more successful when they have a clear agenda, and when leaders take a clear role in making sure everyone gets a chance to speak" (Surowiecki, 2004, p. 182). In such a forum, dissenting opinions are investigated and given a chance to be evaluated. This behavior helps make the group wiser and can change the group's perspective on the issue at hand. However, small groups can become "polarized" (Surowiecki, 2004, p. 184) and stop performing. This means there are extreme and irreconcilable opinions within the team.

If a group becomes polarized, the cause can be twofold: either a group member feels that his or her opinion has not been thoroughly heard and discussed, or group members become more radical and take their opinion to the extreme as a consequence of group deliberations. In order to depolarize such a group, Surowiecki (2004) suggests appointing one person, whose opinion will not sway to one extreme or the other, as a mediator (Surowiecki, 2004). The mediator then divides the entire group based on their extreme opinions. These sub-groups are then further divided into even smaller groups. The smaller groups are then asked to deliberate and formulate an opinion. Within these intimate groups, further discussions help depolarize each group. This process allows them to become more accurate and open to facts and dissenting opinions. This method also helps the team arrive at better recommendations or solutions. After each group member reaches a conclusion, the mediator polls them, tabulates their opinions and statistically calculates the group's aggregate average opinion. Using this method, a group cannot piggyback on the opinion or the knowledge of a single team member.

When a group of experts begins to work well together, they are considered to have a high degree of cohesion. However, cohesive teams sometimes fall into bad habits.

For example, when the team leader or another influential member publicly announces their decision, sometimes team members make the same choice as the leader against their better judgment. This phenomenon is known as an "information cascade." Each member thinks that they made a rational choice because others made the same choice. This happens when financial markets or just a market sector such as the technology market or the gold market experience excessive price fluctuations, and investors go against their own rational investing knowledge and purchase at an inflated price. "Herding behavior" takes place when such cascades last long periods of time and people trade based on emotions rather than sound judgment and buy too much stock at too high of a price, causing market bubbles that cause many people to lose their investment when such bubbles burst eventually. However, in *The Wisdom of Crowds*, Surowiecki (2004) does not offer any viable solution to minimize the effects of an "information cascade" or the "herding behavior." He makes no recommendation beyond recognizing the behavior as it occurs.

Small groups are at greater risk of making biased decisions. Surowiecki (2004) points out that their decisions are often swayed toward one extreme opinion or another, and they have a greater tendency to be influenced by the opinion of the most powerful or authoritative person in the room (Surowiecki, 2004). On the other hand, Surowiecki (2004) finds that people in such groups have the potential to work harder, think smarter and overcome their individual limitations, which can lead to better conclusions. Surowiecki (2004) calls this phenomenon "intellectual swing," which is similar to sport teams "swinging" when anticipating their teammate's next move and re-positioning themselves in response or in anticipation to a changing game (Surowiecki, 2004, p. 176). Just like Michael Jordan and the Chicago Bulls "swinging" during the 1990s, similar favorable team dynamics led Motorola to excel in the consumer cell phone industry and Apple Computer to innovate desktop operating systems, which propelled these companies to the top of their industries and challenged their competition to catch up.

In summary, in order for organizations to derive the maximum benefit from the group's collective wisdom, it is essential for management to communicate to group members their role in the decision making process, to reinforce the importance of their

contribution to the organization, and to stress that dissenting opinions are encouraged and welcome (Surowiecki, 2004). Organizations can mitigate the effect of groupthink by creating a framework that supports a safe team environment that allows individuals to present their research and to voice their opinions, even when they run contrary to the majority opinion, to debate the positive and negative aspects of even unpopular viewpoints, and to play devil's advocate at any point during the group discussion. Organizations can mitigate information cascade and herding behavior within their teams by giving them access to outside experts who can present background information, offer relevant advice and evaluate a strategy without bias. If a group reaches an impasse such as polarization, an organization needs to be ready to appoint a mediator who calls on individual members to offer recommendations or strategies and organizes an anonymous vote on the best solution. In order to build high performance teams, organizations need to develop the structure and strategies that helps teams maximize the benefits of group collaboration while guarding against the potential pitfalls of group dynamics.

5. An Argument for Seeking Out the Wisdom of Crowds

In top-down organizations, deliberation and decision making is removed from front-line personnel and, as a result, senior leadership often delivers impractical solutions that are difficult to implement. In 2003, for example, the DoD specified that evolutionary acquisition (EA) be the preferred approach in weapon system acquisition and spiral development be the basis for implementation. However, a 2006 Rand Corporation brief titled "Evolutionary Acquisition Is a Promising Strategy, But Has Been Difficult to Implement" (RAND, 2006) recognized that in the early stages of system acquisition, the regulations approved by Congress and implemented by the DoD require a level of detail for a program's life-cycle cost projection that makes it extremely challenging to accurately estimate life-cycle cost. The root causes are the indeterminate nature of spiral development and the inherent complexities of determining the program cost estimates. Therefore, the government and the DoD should recognize that system acquisition can benefit from involving frontline employees in revising procedures and by delegating decision making to the broadest group of stakeholders.

The DoD needs to encourage and incentivize its staff for sharing their knowledge and expertise and seeking out new commercial solutions. This means that the DoD needs to revise its incentive structure to align individual incentives and compensation with DoD interests and goals. In the private sector, corporations offer financial and other incentives to employees. Recently, stock options have become popular incentives, since they give employees a financial stake in the long-term growth of their employer. However, Surowiecki (2004) quotes from *In the Company of Owner* (Blasi & Kruse, 2003) that employee involvement still remains low, since the vast majority of U.S. corporations do not make any significant effort to implement "high performance" work teams. In order for Congress and the DoD to overcome such barriers to success, the organizational structure and incentive system have to encourage employees to share their knowledge and opinions and to reward their independent analysis and decision making. Organizational policies and procedures must support the manner in which collaborative teams arrive at a decision from the ground up, rather than imposing a decision from the top down.

6. Chapter Summary

Katzenberg and Smith (1993) argue that if organizations do not attempt to understand team development and team building processes, their teams will never reach their full potential. Teams can easily become under-performing due to peer pressure, an overly influential leader and team apathy by obstructing dissenting opinions or by increasing the discomfort team members feel when they voice them. These impediments in team dynamics result in poor decision making, which costs organizations in time, resources and undue team anxiety. In order for organizations to benefit from their team's collective wisdom, it is essential for management to communicate to team members their role in the decision making process, reinforce the importance of their contribution to the organization, and stress that dissenting opinions are encouraged and welcomed.

Surowiecki (2004) identified four conditions that must be present for teams or crowds to make optimum decisions. The four conditions are (1) diversity of opinion, (2) independence of participants, (3) decentralization and (4) aggregation of decision making. The following briefly describes these conditions:

a. Diversity of Opinion

A team or group is only diverse if each person depends only on the information they collect individually, and the group members cannot consult nor share their information with each other to reduce or eliminate the risk of homogeneity. In *Wisdom of the Crowd*, Surowiecki (2004) states that decisions become less accurate when the knowledge within a group becomes homogeneous.

b. Independence of Participants

A team or group risks independence when peer pressure influences opinion. Team members must independently form their own opinions. Participants' independence is important for two reasons: First, it keeps an individual's research mistakes from infiltrating and penetrating into the group's beliefs. Secondly, independent learning is more likely to contribute new information to the group rather than relying on the same data everyone else is familiar with. Surowiecki (2004) states that people are able to specialize and draw on their own personal knowledge and local research when they have independence from the other team members.

c. Decentralization

Surowiecki (2004) states that decentralization of teams encourages independent learning and research, as well as specialization of individuals. This in turn keeps team members motivated and thus inspires cooperation and collaboration as a group to solve difficult problems. Surowiecki (2004) points out that some research creates such an inordinate amount of data that it requires a huge amount of collaboration and coordination between team-members. For example some biology, chemistry and physics projects are so complex that in order to solve a problem, dispersed sub-teams or individual team members are formed and work on a small piece of a much larger problem. Thus, researchers working independently use the Internet to align themselves with like-minded colleagues and form themselves into self-organized decentralized research collectives.

d. Decision Making

Surowiecki (2004) states that teams need an organizational mechanism to turn a multitude of data and/or information into collective decisions. Surowiecki (2004) in the *Wisdom of the Crowd* did not discuss the appropriate decision making methods that distant and independent teams would find optimal in order to collaborate. However, Jeff Howe (2006) in *Crowdsourcing* outlined three methods appropriate for Crowdsourcing:

- Predictive Problem Solving asks team members to vote the best course of action. Winners are determined by either a simple average or statistical analysis.
- Distributive Problem Solving brakes down a problem into ever smaller sub-problems or nodes. Each node is distributed to a team to solve, which allows for nodes to be solved concurrently.
- Brainstorming makes everyone in the group an equal. Brainstorming is used to create a list of solutions, rank them or vote on them and to determine which course of action requires further investigation and research.

Teams sometimes have to solve very complex problems with multi-variable conditions. The use of Group Decision Support Systems (GDSS) can help simplify this process. A GDSS is a computer supported evaluation system designed for a collaborative work environment. Surowiecki (2004) states that conducting and coordinating online deliberations or discussions requires forethought about the optimal mathematical or statistical method to analyze the research data.

This research report does not try to determine which method is best for different types of problems. In *Wisdom of Crowds,* Surowiecki (2004) only identifies the potential problems that may occur in a team or group decision making situation, and the factors that may lead to them, hoping that management or a team leader recognize them and seek a solution. However, Surowiecki (2004) discusses the conditions under which crowds, groups and teams have come together and efficiently solved many varied tasks.

E. LITERATURE SUMMARY

This literature review provides many working examples of successful collaborative efforts and how to manage and leverage them. In *Wikinomics*, Tapscotts and Williams (2006) documented and acknowledged the potential of Web 2.0 tools, Open Innovation and Crowdsourcing. Tapscotts and Williams (2006) discuss established, wide ranging, and varied collaborative efforts within software systems Linux and Mozilla's Firefox, within online encyclopedias Wikipedia and its many offspring such as Wikilaw, Wikitravel, Wikinews, Wikisource, which all tap voluntary contributions into the topics and questions they offer. The authors include more specific examples such as non-profit scientific projects like the Human Genome Project, the Life Science Grid (LSG) and the European Bioinformatics Institute, and for-profit organizations such as financial institutions like Marketocracy Capital Management, and other for profit organizations including IBM, P&G, Eli Lilly and Amazon.com. Simply by recording and acknowledging these and other examples, Tapscotts and Williams (2006) show that a collective online network can drive both non-profit and for-profit organizational innovation, development and growth.

The second work, *Open Innovation*, edited by Henry Chesbrough, Wim Vanhaverbeke and Joel West (2006), discusses the organizational groundwork and support required to run a successful open network and manage Open Innovation and Crowdsourcing projects. Chesbrough and his co-authors address the real complexities involved in administrating open network projects, going as far as suggesting that organizations adopt these techniques and plan for re-organization and organizational realignment within new markets, such as that experienced by IBM and P&G. *Open Innovation* (2006) addresses how organizations adopting open strategies will seek and organize information and ideas, how they conduct research and development, manage their intellectual property as well as their teams. Chesbrough and his collaborators draw from a wealth of experience plus many years of academic research in order to provide the best business practices surrounding the subject.

Surowiecki's *The Wisdom of Crowds* (2005) examines the value of tapping the knowledge found within crowds. Surowiecki supports the value of crowd-based-decision-making and cites examples from sociology and biology in order to describe crowd and team behavior and examine whether or not large groups of individuals are wiser than a single expert, and determine best practices in the dynamics of group decision making. Finally, Surowiecki provides solutions to effectively manage teams and open networks.

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IV. REVIEW OF PERTINENT FEDERAL ACTS

The government does not explicitly restrict the use of Web 2.0 technologies, Open Source development and/or Crowdsourcing by government agencies. This is because many of the concepts are new and there have not been any scandals involving the concepts addressed in this report. Therefore, these concepts have gone largely unnoticed by Congress and, until a high-profile incident occurs, Web 2.0 technologies, Open Source development and/or Crowdsourcing probably will remain unregulated. However, there are a number of existing acts that have an impact on these technologies.

The Clinger-Cohen Act authorizes the government bureaucracy to develop and use technology in order to help improve efficiency and reduce the cost of government. In addition, the E-government Act establishes the framework for promoting interagency cooperation and using Internet technology for this purpose. Further, the Bayh-Dole Act sets parameters for competitive patenting of university research, which prompted some in the scientific community to promote and advance Open Source development. The legal framework is further refined through a series of federal acts such as the National Cooperative Research Act, the Federal Technology Transfer Act, the National Cooperative Research and Production Act and the Cooperative Research and Technology Enhancement Act. They promote the government and commercial industries to enter joint and collaborative research agreements as well as transfer agreements. They also changed ownership and patent law. Finally, the Antideficiency Act restricts government agencies from using “free” volunteer labor that is rendered with the implicit expectation that there is a guarantee of future revenues. Since Crowdsourcing is driven by volunteers, government users must be aware of the boundaries surrounding the use of free labor.

A. THE CLINGER-COHEN ACT OF 1996 (THE INFORMATION TECHNOLOGY MANAGEMENT REFORM ACT OF 1996)

Along with other purposes, the Clinger-Cohen Act (CCA) of 1996 provides the authorization to reform acquisition laws and information technology (IT) management of the federal government. Government IT, as defined under the Act, is to be operated as an

efficient business. Therefore, acquisition planning and management of technology are to be treated as a "capital investment." As in private industry, capital planning decisions within the government need to take into consideration the cost/benefit ratio, a technology's life cycle and the degree of flexibility the technology offers to serve multiple stakeholders.

The Clinger-Cohen Act opens up the possibility of government agencies combining resources on basic R&D programs. The CCA instructs large numbers of federal agency Chief Information Officers (CIO) to collaborate on: (a) the development of IT infrastructure, (b) the development and standardization of IT architecture, (c) the standardization of management and control and (d) the development of planning and guidance in identifying opportunities and cooperation on future IT and management issues. Additionally, because the CCA also integrates IT capital planning, it instructs DoD agencies to align within the context of the DoD Planning, Programming and Budgeting System (PPBS). Three years after the passage of the CCA, Congress strengthened the DoD CIO's responsibilities to make DoD systems interoperable and to eliminate IT duplication. Therefore, the CCA authorizes DoD CIOs to collaborate and coordinate efforts, particularly in software applications and computer hardware, as well as in R&D pertaining to design, development, implementation and support or management of computer-based information systems.

The CCA can be interpreted as allowing IT professionals across government or DoD agencies to use Crowdsourcing methods to bring together a larger, diverse group of qualified individuals to map out the standards, management and control procedures and policies that underlie complex technological solutions. Crowdsourcing also may accelerate the software development to eventually allow the huge discrete DoD databases to be mined for data and trends and to analyze this data in order to streamline financial budgeting and forecasting, to identify customer purchasing or product usage patterns, and to share research data in the fields of medicine, biology and chemistry. Collaboration across government agencies as mandated in the CCA can support a project such as the adoption of open office software that is common across all government agencies. Such

collaboration could faster uncover software bugs, beta-test new applications, write software patches and upgrade office applications faster.

In summary, the CCA can be interpreted as supporting the DoD CIO's effort of benchmarking successful commercial Crowdsourcing strategies, such as in software development and data management, in order to lower software application development cost. In addition, the CCA supports collaboration between DoD agencies sharing IT infrastructure resources and technologies. Further, based on the essence of the CCA, it can be surmised that DoD CIOs are allowed to initiate government Crowdsourcing events to co-develop programs between private industry, universities, non-profit organizations and multiple government agencies.

B. THE E-GOVERNMENT ACT OF 2002 (PUB.L. 107-347, 44 U.S.C. § 101)

One of the declared rationales of establishing the E-Government Act was to create the federal Chief Information Officer (CIO) within the Office of Management and Budget. The CIO's responsibility is to promote increased use of and improve the management of governmental electronic services. The CIO also is to oversee improvements in citizen access to government information and services through Internet-based technology. The E-Government Act creates the mandate that government is to:

- Improve the management and promotion of electronic government services and processes;
- Establish a framework for Internet and information technologies to provide increased public participation in government;
- Promote emerging Internet technologies across government agencies;
- Promote interagency collaboration;

The E-Government Act largely supports the ideas of Crowdsourcing. Because Crowdsourcing requires the open solicitation of ideas and knowledge and invites everyone, from the lone inventor to cross-functional technology teams, to participate, it becomes a small democratic forum, which fulfills the ideals of increasing public participation. Further, the Crowdsourcing effect of increasing participation of specialists lends support to the idea of interagency collaboration, especially in R&D. If

Crowdsourcing advocates are correct, Crowdsourcing can improve the government's ability to achieve agency missions and program performance goals through greater collaboration and reduced duplication of effort.

C. THE BAYH DOLE ACT (PATENT AND TRADEMARK ACT AMENDMENTS OF 1980)

Over the years, Congress has sought opportunities to share federal intellectual property with the private sector by improving access and methods of dissemination. To promote collaboration between the government and commercial and nonprofit organizations, Congressional policy (35 U.S.C. §200) calls for the use of the patent system to exploit intellectual property originating from federally supported R&D. One of the most important tools to reach this goal has been the Bayh-Dole Act (P.L. 96-517, Patent and Trademark Act Amendments of 1980), which "ensures that inventions made in collaboration between the federal government and nonprofit organizations, including universities, are used to promote competition without unduly encumbering future research and discovery."

The Bayh-Dole Act of 1980, together with its 1984 and 1986 amendments, changed the way intellectual property arising from federally funded research is controlled. Specifically, it gives nonprofit organizations, universities and small businesses the option to hold title to inventions they developed with federal funding. In addition, the Bayh-Dole Act gives federal agencies the ability to grant an organization the exclusive license on federally owned patents that originate from research conducted in a federal laboratory.

Most importantly, the Bayh-Dole Act permits universities, small businesses, or non-profit institutions to pursue ownership of their inventions even though that research was government funded. The royalties from such ventures are shared between the institution and their inventors, while the surplus is used to support the technology transfer process. Thus, Bayh-Dole Act gives universities and other institutions title and financial control of their inventions at the completion of federally funded research programs.

In 1980, the federal government retained title to approximately 30,000 patents, of which only 5% were used to advance research leading to new or improved products (Shelby, 2008). The government did not possess the resources to develop and market these innovations or inventions. With the passage of the Bayh-Dole Act, Congress turned universities into innovation incubators for breakthrough technology. Since its passage, the yearly number of patents filed has increased significantly, which is attributed to universities filing patents stemming from research funded by the government (Chesbrough, 2006). Research conducted by the Congressional Research Service estimates that the business conditions brought about by the Bayh-Dole Act resulted in 4,500 new firms over 30 years (Schacht, 2008). Schacht (2008, p. 13) observes that "of these, 2,671 were still in operation by the close of FY2004." Thus, the act caused technology transfers that led to a high number of innovation spin-offs, because researchers were able to patent their work initiated at research institutes but funded by federal programs. Stanford University, for example, owns the patent on Google's Internet search technology. Revenues from this patent, along with 427 technologies licensed to businesses, have helped the university earn $48 million in CY 2007 (Jones, 2008).

However, U.S. contributions to global knowledge and innovation are stagnant. The Bayh-Dole Act did change the nature of relationships between universities, the federal government and industry. However, with government fiscal constraints arising during the mid-1970 through 80s, Congress expected the passage of the Act to result in greater industrial and commercial funding of R&D projects. The expectation was to spur a surge in innovation in order to guarantee the United States' position as a technological world leader. Mowery, Nelson, Sampat, and Ziedonis (2001) stated in the journal *Research Policy* that university patenting surged during the 1980s and early 1990s. They found this increase was not limited to top universities but also included many second-tier universities. Moses and Martin (1999) reported in the *Journal of the American Medical Association* that between the years 1990 and 1999, gene patents increased from 400 to 2,800, while the number of patents granted to universities increased from 55–73%. During the same period, the Web site *Biotechnology Industry* (http://bio.org) also documented the increase in biotechnology patents granted from 1,765 in 1990 to 7,763 in

2002. However, in *Open Innovation*, Fabrizio (2006) asserts that the Bayh-Dole Act started to slow the transfer of innovation. Fabrizio (2006) found these new dynamics especially true in the medical, pharmaceutical and biotech industries, as well as in the chemical and chemical product industries.

According to Fabrizio (2006), the Bayh-Dole Act fences off research. Prior to the Act, research results were normally published and peer reviewed, and university researchers would petition the government for the patent rights to their own work. This in turn prompted future research and spin-offs of similar technology. During this period, the belief prevailed that if the government paid for it, the public owned it. This concept governed the right to use basic research on antibiotics, nuclear physics and agriculture. However, in 1979, an audit of 28,000 government-held patents, which were all developed with public funds, showed that no more than 5% had been commercially exploited (Leaf, 2005). For-profit organizations believed there was too much financial risk in investing capital to commercialize government-owned patents; corporations wanted an avenue to gain ownership of these patents (Leaf, 2005). Companies were reluctant to do business with the federal government until the Bayh-Dole Act simplified the transfer of patent ownership by altering the legal framework surrounding R&D and patent ownership. Now individuals and commercial enterprises automatically have the right to the patent after completing their research.

After passage of the Act, these patenting and licensing activities increased the cost of innovation. In addition, the patent process limited the number of firms willing to pay for further research into an innovation, restricting follow-on innovation. Fabrizio (2006) also documented that because of patenting, less information was shared in publications, diminishing follow-on research. Moreover, Fabrizio (2006) found that patenting decreased the accessibility of research or patented technologies, increased the cost of making use of research findings and caused delays due to the patent negotiation process.

Traditionally, university research and its associated intellectual property was characterized by open disclosure and rapid dissemination because the incentive structure promoted collaboration among colleagues and other research institutes, information

dissemination and purposeful knowledge transfers. The passage of the Act resulted in greater investment from the pharmaceutical and chemical industries in university research. It also resulted in a change in researchers' incentives and behaviors, leading to more secrecy and less open sharing of information, because industry wanted to protect their right to inventions and future patents. Also, because of the commercial value of innovations, research became walled off and was no longer published and subjected to peer review. This shift in norms was inhibiting and restricting the widespread dissemination of research knowledge across commercial organizations and between researchers.

The findings reported by Fabrizio in *Open Innovation* (2006) highlight the fact that increased patenting does not directly further knowledge dissemination and innovation. In addition, patenting university research does not assure technology transfers from university researchers to industry.

D. THE NATIONAL COOPERATIVE RESEARCH ACT AND MODERN CHANGES TO JOINT RESEARCH LEGISLATION

In response to the 1970s and early 1980s recession and stagflation, the U.S. Congress attempted to copy European and Asian economic strategies in order to foster prosperity by helping industries gain a competitive advantage in global markets. Congress intended to promote economic activity by incentivizing business investment into R&D and by encouraging businesses to form joint ventures. Congress did not intend to exercise central control over the economy as in some European and Asian countries. However, private industry avoided collaborative projects and joint ventures with other organizations due to the Sherman Antitrust Act of 1890 and the Clayton Antitrust Act of 1914, which banned rival firms from collaborating on joint production or project work. Industry viewed collaborative projects as too risky because of the threat of an anti-trust violation and the resulting harsh penalties.

In an effort to stimulate the U.S. economy in the early 80s, Congress endorsed collaboration between businesses, universities, non-profit institutions and government laboratories in order to accommodate commercial industries and to encourage greater

private investment into technological innovations. Congress began to draft new legislation with the expectation of increasing long-term investment in R&D programs. In 1984, Congress passed the National Cooperative Research Act (NCRA), Public Law No: 98-462. This changed government policy regarding R&D joint ventures with the ultimate goal of improving efficiency and eliminating redundancies in the R&D process. The benefits of the Act are summarized as follows:

- The Act promotes industry-university-government co-operation in science and technology by providing businesses special privileges and the legal framework to form joint ventures for conducting R&D.
- The Act allows industry and universities to financially benefit from federally funded government research by giving them legal protection and full or partial intellectual property rights.
- The Act helps prevent wasteful duplication of research by encouraging private industry to form joint ventures or limited partnerships to pool resources and share in the cost of conducting research together.

Traditionally, many U.S. firms are unwilling, or unable, to take on a long-term commitment such as R&D by themselves. This is especially true for small businesses. Hypothetically, joint ventures allow companies to contribute complementary assets and resources to achieve synergy and attain economies of scale and scope while sharing the financial risk when a project is very costly or very risky due to uncertain demand or new technology. One company, for example, may provide intellectual property, while another provides capital or financing and yet others contribute laboratory space, management and labor. The goal of a joint venture is an innovative product that is marketed by each of the contributors, or by a new firm of which each of the joint venture partners owns a share. (Schnitzer, 1987, p. 166; Shapiro and Willig, 1990, p. 114).

Nevertheless, the NCRA does not grant antitrust protection for production joint ventures, nor does it offer full protection from antitrust laws in R&D ventures. Thus, participants of joint ventures who are found in violation of the NCRA risk fines in the amount of triple the damages. In addition, the NCRA weakens U.S. government policy supporting market competition and has sometimes been interpreted as anticompetitive by the courts. Due to these conditions, many businesses avoid joint ventures because they perceive their risks to outweigh the benefits.

Throughout the 1990s and early 2000s, Congress continued to revisit the laws and policies governing joint ventures in an attempt to fix problems not addressed by the NCRA. The following Acts address the general policy toward joint collaboration between industry, universities and government.

1. Federal Technology Transfer Act (FTTA) of 1986

The FTTA allows businesses and federal laboratories known as government-owned, government-operated labs (GOGOs) to form partnerships to develop and bring new technologies to market. The FTTA explicitly authorizes cooperative R&D agreements known as Cooperative Research and Development Agreements (CRADA) between GOGOs and non-governmental or commercial organizations. The FTTA also permits federal agencies to award employees who were instrumental in creating an innovation or invention a share in the royalties when their agency retains ownership of a patent. In addition, if an agency decides not to patent an invention, agency employees have the right to patent and market the invention themselves.

2. National Cooperative Research and Production Act of 1993 (NCRPA), 15 U.S.C. § 4301-06

Congress passed the NCRPA to further reduce the risk of companies violating antitrust laws with joint ventures that conduct R&D, jointly produce a product or service and/or develop and market industrial standards that penetrate the marketplace and further collaboration between its key players.

3. The Cooperative Research and Technology Enhancement (CREATE) Act of 2004, 35 U.S.C. 103(c) and Public Law 108-453

CREATE permits multiple owners to be listed on a patent application or patent. It also allows for multiple owners to be treated as one common owner for the purpose of excluding “prior art” in the event of a rejection by the United States Patent and Trademark Office (USPTO). The 2005 amendments to the Act state that in order for patents to have common or multiple owners (Clarke & Clark, 2005), the following conditions have to be met:

- The invention in question was made by or on behalf of the joint venture partners and a joint research agreement was in effect on or before the date the invention was made;

- The invention was the direct result of efforts that were within the scope of the agreement; and

- The patent application includes, or is amended to disclose, the names of the joint venture partners bound by the agreement. (Clarke & Clark, 2005)

The requirements for commercial products and services have become ever more complex and require more resources in the form of time, knowledge and capital than any one organization alone can muster. The government has recognized the need to relax many of the laws that were enacted initially to protect people from exploitation through commercial monopolies. Congress in the 19th and 20th centuries could not have anticipated the complex science required to design and build a modern automobile, create a computer network or splice genes. However, in recent years, a modern U.S. government has come to accept that joint research and collaborative research agreements are required to produce globally desired technologically advanced products in order to protect U.S. trade and our economy. Nevertheless, joint and collaborative agreements call for their own set of sophisticated laws on ownership of R&D outcomes. Hence, Congress amended laws governing contracts, grants and other types of agreements that allow federal laboratories and universities to work jointly with private industry in creating innovative technology.

Crowdsourcing and Open Innovation techniques and processes will create a new level of complexity in joint research and development projects since these practices invite a large number of people to participate in the creation of an innovation. Some participants may want to contribute a patent they own, assuming that they will collect a royalty or payment. Therefore, Congress will once more have to revisit and update laws to create a legal framework surrounding these new and revolutionary collaborative practices within a virtual environment. In the past 30 years, Congress has demonstrated its ability to be flexible in updating laws to meet the needs of an ever-changing business environment. Adoption of Crowdsourcing and Open Innovation will require further flexibility as these business practices become more commonplace.

E. THE ANTIDEFICIENCY ACT

The Antideficiency Act (ADA) prohibits federal agencies from obligating or expending federal funds in advance or in excess of an appropriation or apportionment per 31 U.S.C. § 1351 and 31 U.S.C. § 1517(a). Putting it more simply, Congress legislated that federal agencies cannot spend—or promise to spend—any monies for any purpose, unless Congress explicitly authorized or apportioned funding for a specific purpose. The Antideficiency Act is the statutory law that Congress uses to carry out its constitutional control of the public purse.

The ideas and concepts of upholding the ADA have evolved over time. The Antideficiency Act came about during the post-Civil War period, when it was not uncommon for agencies to incur obligations in excess, or in advance, of Congressional appropriations. Actions such as these forced Congress to continually re-appropriate funds for unauthorized purchases. The ADA has become Congress' strongest means of control over government agencies by authorizing and limiting public funds. The Antideficiency Act is also seen as a Congressional constraint on presidential powers to appropriate funds.

By Executive Order 6166, the president transferred Antideficiency Act authority to the Director of the Office of Management and Budget (OMB) in June 1933. In 1982, Congress rewrote the Antideficiency Act in an attempt to modernize its language without changing its meaning. Congress' intent for rewriting the ADA was to provide effective control over the use of appropriations and to hold accountable government officials who obligate appropriations without proper authorization or at an excessive rate. The list below is taken directly from the Antideficiency Act (31 U.S.C. § 1341). In its current form, the law prohibits (Principles of Federal Appropriations Law, 2006):

- Making or authorizing expenditures from, or creating or authorizing an obligation under, any appropriation or fund in excess of the amount available in the appropriation or fund unless authorized by law. 31 U.S.C. § 1341(a)(1)(A). Involving the government in any obligation to pay money before funds have been appropriated for that purpose, unless otherwise allowed by law. 31 U.S.C. § 1341(a)(1)(B).

- Accepting "voluntary services" for the United States, or "employing personal services not authorized by law," except in cases of emergency involving the safety of human life or the protection of property. 31 U.S.C. § 1342.
- Making obligations or expenditures in excess of an apportionment or reapportionment, or in excess of the amount permitted by agency regulations. 31 U.S.C. § 1517(a).

The principles underlying the Antideficiency Act stipulate that government officials may not make payments or commit the United States to make payments unless Congress has set aside and approved the expenditure of funds for that purpose. An officer or employee who violates 31 U.S.C. § 1341(a) is subject to administrative and penal sanctions, including suspension from duty without pay or removal from office (31 U.S.C. § 1349(a), 1518). In addition, an "officer or employee who knowingly and willfully violates any of the provisions cited above shall be fined not more than $5,000, imprisoned for not more than 2 years, or both" (31 U.S.C. § 1350, 1519).

1. Voluntary and Personal Services

The ADA prohibits voluntary and personal services. Both prohibitions negate important Crowdsourcing methods, which invite numerous volunteers to collaborate with each other in developing a product prior to the issuance of a government contract. Therefore, government officials risk violating the ADA by initiating Crowdsourcing events because a government official must not ask or solicit potential contractors to provide volunteer services in order to create a product or service without any promise of funding or provisioning of specific appropriations. Moreover, a government official risks breaking the rule concerning personnel services by directing a contractor to investigate a possible solution to a problem.

Problems with Crowdsourcing arise when government officials cannot directly obligate any contractors in excess or in advance of appropriations. In the past, agencies accepted "voluntary" services, knowing that Congress would eventually reimburse the contractor. In an early 20th century Attorney General decision, 30 Op. Att'y Gen. 51

(1913), the courts determined that there is a distinction between true "voluntary services" and "gratuitous services." The Comptroller General noted in 31 U.S.C. § 1342 that

> The voluntary service referred to is not necessarily synonymous with gratuitous service, but contemplates service furnished on the initiative of the party rendering the same without request from, or agreement with, the United States therefore. Services furnished pursuant to a formal contract are not voluntary.

The Comptroller of the Treasury, the General Accountability Office (GAO) and the Justice Department adopted and follow this distinction.

According to Random House's *Unabridged Dictionary* (2006), normally "people associate volunteering with a person who offers themselves for a service or undertaking willingly and without pay" where a "person is not legally nor morally bound to do so and has no interest to protect or in making payment." However, "volunteering" can also refer to a service provided by a private person without any prior contract or obligation. Therefore, a government official working with a contractor must guard against potential conflicts arising from asking a contractor to perform a "voluntary service" while the contractor assumes that future compensation is implied. For instance, problems can develop after a contractor performs a volunteer act, especially when there is a prior contract and the contractor expects and thus seeks compensation. In addition, government officials can violate ADA regulations against "personal services" if a consultant is led to assume that providing a "voluntary service" is a condition of "employment." Crowdsourcing events sponsored by government officials can easily cause individuals and organizations to assume that future compensation for their contributions will be provided and, thus, put officials in conflict with existing laws.

2. Solving the Problem of Volunteerism

GAO decisions have confirmed basic government-wide authority for procuring experts and consultants, 5 U.S.C. § 3109, which allows for provision of services without compensation without violating the Antideficiency Act, as long as it is clearly understood

and agreed upon that no payment or other compensation is expected. The GAO holds that contractors, consultants and other experts can agree to deliver “voluntary services” by the following legal means:

(1) By setting their compensation at zero,

(2) By appointment without compensation, or

(3) By signed waiver of compensation, either entirely or partially.

Nonetheless, while the above stated guidelines remain valid, there have been cases wherein the courts have overruled an agency’s understanding about volunteer consultants. The Comptroller General in 55 Comp. Gen. 109 (1975), for example, overruled the agency’s determination on factual grounds, because additional information showed that the individual involved in the case was a “de facto employee” performing under color of appointment and thus had a valid claim for compensation. The case established that a true volunteer has no “color of appointment” or other indication of lawful employment. These opinions are further supported by 31 U.S.C. § 1342, where in specific situations uncompensated participation in pre-bid conferences, on-site inspections or bid openings must be regarded as “technical violation” of the Antideficiency Act.

GAO decisions state that if individuals acknowledge in advance and in writing that they will receive no compensation, and waive any and all claims against the government on account of their service, they can legally serve as “volunteers.” Therefore, in order to avoid violations of the Antideficiency Act in a Crowdsourcing event, or in an Open Innovation network, each contributor must be asked to sign a waiver each and every time prior to participating in a forum. A simple online procedure ensures compliance: Prior to logging on to the secure Web site, each volunteer has to review and acknowledge a document that details the conditions of volunteerism and communicates the fact that there is no payment for participation.

F. CHAPTER SUMMARY

Research shows that the government supports collaborative projects. Congress has modified laws to allow patents with shared ownerships, to permit the transfer of government-owned intellectual property to new owners with the resources to commercially exploit the technology and to promote collaboration between federal agencies and GOGO laboratories, universities and commercial industry. In addition, the government is modernizing its past policies and procedures to include e-business practices. However, caution must be exercised, because antitrust violations are determined on a "per se" basis. Final judgment of a complaint is made only after an individual or an organization files a protest with the government. Therefore, organizations that invest their time and resources creating a joint agreement might lose the rights to an innovation, have to share their rights to an innovation or have to pay royalties for the use of a prior patent because of an oversight during the patent search. It is recommended that in the existing legal environment, Crowdsourcing participation require multiple layers of legal releases to assure that the development process does not utilize patented technology without the owner's consent and that innovations created through Crowdsourcing include a clause allowing the government royalty-free rights for the entire patent life.

The next section of this research report examines how the government currently creates and acquires innovation and new technology.

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V. CURRENT MEANS OF SOURCING INNOVATION

The government pursues national economic benefits by investing in innovative research. Funding for research is divided among the numerous government agencies with research programs that, at times, develop breakthrough or disruptive technologies. To reduce the risk to the government, research programs are subject to proven acquisition strategies that lead to decisions based on best practices. The purpose of this process is to ensure the quality of program outcomes and their execution by mitigating the risk inherent in innovative technology and manufacturing processes. Therefore, it is important to understand how acquisition strategies pass down from the President and the impact that the management of acquisition programs and their administration have on innovation.

The Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) is the principal subject matter expert for DoD acquisition and contracting policy for the Office of the Secretary of Defense (OSD). The USD (AT&L) translates national and defense strategic guidance, in particular the Quadrennial Defense Review, into actionable policies and guidelines. These policies and guidelines serve as organizational goals aligning the DoD acquisition communities with the OSD's transformation priorities. Their ultimate goal is to optimally support military personnel, who are the agency's ultimate customers, with innovative defense technologies. The USD (AT&L) thus promotes the development of reliable programs and acquisition strategies and facilitates communication and collaboration within the DoD acquisition organizations.

Defense Procurement, Acquisition Policy and Strategic Sourcing (DPAP, 2009) is responsible for all acquisition and procurement policy affairs in the Department of Defense. DPAP serves as the principal advisor for all major weapon systems programs, major automated information systems programs and services acquisitions. DPAP plays a key role in the acquisition process by developing department level acquisition policy (DoDD 5000.1 & DoDI 5000.2) and by actively participating in Integrated Product Teams at every level. DPAP is instrumental in creating the policy and business strategies

that guide program teams acquiring innovative research. Moreover, DPAP ensures that innovative DoD acquisition and contracting strategies reflect good business practices and are consistent with current statutes. The acquisition methods underlying these programs are grants and "other transactions," the small business innovative research (SBIR) program, the small business technology transfer program (STTR) and Cooperative Research and Development Agreements (CRADA) discussed below.

A. EXECUTIVE ORDER 13329 ENCOURAGING INNOVATION IN MANUFACTURING

On February 24, 2004, President George W. Bush signed Executive Order 13329, Encouraging Innovation in Manufacturing. This executive order identifies the duties of federal agencies and departments in the execution of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. The executive order states that technological innovation is at the center of a strong industrial manufacturing base, which is crucial to the United States economy. Furthermore, the executive order acknowledges the important role SBIR and STTR programs play in stimulating the U.S. economy by commercializing innovative technologies and products. The executive order also recognizes the significant contribution to national defense that small businesses make by participating in SBIR and STTR research and development in areas such as healthcare, welfare, the environment and industry.

1. Current Presidential Policy

The President's 2008 Budget addressed research and development, stating that the economic returns from research come in the form of process and product innovations that reduce production costs and product prices and result in new and improved products and services. This mandate reinforces that the federal government must support the President's American Competitiveness Initiative (ACI) through policies and programs that strengthen the nation's economic competitiveness. Therefore, Congress introduced processes to transfer research and technology from government laboratories to the

commercial market. Small business programs like STTRs and to some extent SBIRs, are means to achieve this goal. STTRs and SBIRs contract types are explored further within this chapter.

B. BROAD AGENCY ANNOUNCEMENTS (BAA)

The DoD and subordinate agencies involved in R&D solicit for specific ideas through *Broad Agency Announcements* (BAA). BAAs are published periodically, usually several times a year and request proposals for two purposes: (1) for basic and applied research that advances technology development and (2) for scientific studies intended to advance existing knowledge and understanding (Broad Agency Announcement, 2004). BAAs result in contracts (including SBIRs and STTRs, grants and other types of awards) and are regarded as highly competitive.

BAAs are provisioned under FAR 6.102(d)(2) for competitive selection of offers. Offers selected for award are the result of full and open competition. They are compliant with Public Law 98-369 and the Competition in Contracting Act of 1984. BAAs result in awards to organizations of all sizes, from large corporate organizations and small businesses to universities and non-profit institutions. Although not considered a set-aside program, these contracts or grants are often awarded to small disadvantaged businesses, historically black universities or minority institutions. The intent of the DoD and its agencies is to ensure that their acquisition programs are openly competitive and strive to harness the innovative talents of U.S. industry and organizations for the benefit of U.S. military and economic strength.

C. GRANTS AND OTHER TRANSACTIONS

Federal agencies award “Grants and Other Transactions” (grants) to financially support research benefiting the public. In general, universities and non-profit institutions, state and local governments as well as cooperative extension services receive federal grants to fund basic as well as applied research to develop new manufacturing technologies and transfer methods and technologies across industries. DoD grants are competitively awarded federal assistance agreements that fund collaborative programs

between universities and industry focusing on new or emerging technologies. After their award, grants require no substantial involvement of the DoD with the recipient during performance of the research. Guidance on grants is contained in DoD 3210.6-R, "DoD Grant and Agreement Regulations."

D. CRADA

A Cooperative Research and Development Agreement (CRADA) is a type of legal agreement between a government entity, normally a government-owned government-operated (GOGO) laboratory and a private or non-profit organization, usually a corporation, industry group, or university, for the purpose of research and development. The objective of a CRADA is cooperative research that supports the command's mission, while at the same time benefiting the partnering organizations. CRADAs are created between two or more participants; one is always the government, the other(s) are non-governmental. They form a partnership that allows them the opportunity to leverage each other's strengths. The benefit to both the government and industry is the opportunity to gain a competitive advantage in the commercial marketplace through access to expertise and patents and to make the most of limited resources. Resources come in the form of highly trained and knowledgeable researchers, specialized business practices, unique facilities and/or specialized equipment.

Even though CRADAs are contracts and written agreements signed by all responsible parties, they fall outside of the government's FAR regulations and acquisition/procurement processes. The CRADA agreement defines the individual responsibilities of each party and the rights to intellectual property developed under the agreement. While CRADAs do allow exchanges of value in the form of facilities, experts, patents, etc., between the government and its partners, they do not permit payment of federal funds to the non-governmental entity. The advantage of CRADAs to the government is in the reduction of the amount of time it takes to form a partnership. In addition, they are easily renewed and/or modified as the conditions of the arrangement change. Another advantage to the government is the government's preservation of the legal right to use the invention royalty free in the form of a universal, non-transferable,

irreversible and paid-up license. The advantage to the non-governmental partner is exclusive access to a patent, license or invention made or partially made under the agreement. CRADA agreements also can grant the non-governmental partner proprietary use of all data or information created during development for up to five years.

The Federal Technology Transfer Act of 1986 (P.L. 99-502) establishes the federal government's authority to set up CRADAs and provides the means and mechanisms to transfer technology to non-governmental organization as mandated by the Stevenson-Wydler Act, and Title 15 United States Code Section 3710a. Besides the goals of CRADAs stated above, the Stevenson-Wydler Act makes the transfer of government owned technology, in the form of intellectual property and patents, the responsibility of the federal government with the goal of supporting private industry interests to commercialize the technology. Historically, the best CRADA partners are innovative and entrepreneurial organizations that have a successful track record of taking technology out of the laboratory into a competitive market and of serving the public good.

The U.S. Joint Forces Command's (USJFCOM) Office of Research and Technology Applications (ORTA) is one of the DoD's entryways for a command to transfer technology using CRADAs. Organizations can find advice and assistance through the USJFCOM-ORTA or through other government ORTA offices, such as information Small Business Innovative Research (SBIR) projects, personnel exchanges, patent licensing agreements and intellectual property agreements. Below are examples of CRADA applications:

- CRADA SOW provides for the federal lab to use its proprietary assay technology to test CRADA partner's drug for new use. The lab provides the partner with a report; the partner pays lab fees.
- CRADA SOW provides for the non-federal CRADA partner to send two scientists to work at a federal lab for 6 weeks and use the lab's unique technology to test the CRADA partner's drugs for anti-Alzheimer's properties.
- CRADA SOW provides for a federal lab to buy a microscope and send it to the CRADA partner's overseas lab for the partner's contracted technician to read slides. The parties agree that the microscope becomes the property of the partner at the end of the agreement.

Through a CRADA, a GOGO laboratory can gain access to outside expertise and facilities (and, in some cases, funds) that can be used to further the mission goals of the laboratory. In addition, the commercialization efforts of an industrial partner may result in royalty payments to the laboratory as well as relevant laboratory personnel. A CRADA allows a commercial organization to access the expertise of government personnel and the resources (but not funds) of government facilities in order to further its own technology development objectives. Moreover, another aspect of the broader purpose of CRADAs is that they encourage the creation of teams to solve technological and industrial problems for the greater benefit of the country. These teams may be partnerships between federal laboratories and commercial organizations, or between federal laboratories and universities, or just about any combination of federal and non-federal organizations.

E. SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM (STTR)

In 1992, Congress established the Small Business Technology Transfer Program (STTR) under Act 15 U.S.C. 638 as a pilot program. STTRs perform the same function as SBIRs, with the exception that STTRs are used to fund joint R&D projects between small businesses and research institutions, specifically universities, federally funded R&D centers, or nonprofit research institutions. Contracts are awarded to small businesses proposing innovative solutions in order to solve DoD scientific and engineering problems. Similar to SBIRs, the expectation is that proposed solutions have a high potential for private sector commercialization. STTR programs have the same time frame, funding limitations and commercial expectations as SBIR programs. However, small businesses and research institutions must have a written agreement specifying the terms and conditions surrounding intellectual property prior to participating in STTR.

F. SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) PROGRAM

Congress' Small Business Innovative Research (SBIR) program intends to find innovative commercial solutions to challenging technological problems and to promote the participation of small businesses in government programs. The Small Business

Innovation Research Program Reauthorization Act of 2000, Public Law 106-554, amended section 9 of the Act in 2002 (15 U.S.C. 638). Joint ventures and limited partnerships are now allowed under the condition that business entities qualify as a small business according to the Small Business Act 15 U.S.C. 631 and the DoD SBIR Program.

DoD's SBIR programs award early-stage R&D projects to small technology companies based on a proposal's scientific and technical merit and its potential value as a cost-effective method to commercialize innovative technologies. DoD acquisition strategy calls for research to be conducted in three phases. In Phase I, small businesses propose concepts to test the scientific, technical and commercial merit and feasibility of a particular theory. Phase I funding is limited to $100,000 and one year in duration. If the concept is deemed successful, the company is asked to propose Phase II development. If awarded, Phase II is funded up to $750,000 and two years in duration. After Phase II, companies are expected to seek out commercial financing sources to complete final product development and market the product commercially and to the government. The small business that was awarded the SBIR may obtain a patent for an invention because the government relinquishes title to inventions and intellectual property developed under the contract.

G. FEDERAL TRANSFER OF TECHNOLOGY

Despite all efforts on the part of federal agencies, technology transfer programs designed to spin-off commercial applications from government research are not always successful. The CRS Congressional Report "Technology Transfer: Use of Federally Funded Research and Development" the author Schacht (2008) indicates that studies found only approximately ten percent of federally owned patents are ever applied commercially. The report also states that, after the initial phases of the research project, contractors often find their invention and intellectual property have no commercial application and little or no value. According to the report, critics find that the acquisition process between private enterprises and federal agencies remains difficult and inefficient. Critics also argue that the transfer of information, knowledge and skills requires the

assignment of patents and the transfer of intellectual property rights to the contractor. This process has become complicated, expensive and time consuming.

The CRS Congressional Report states that contractors encounter other barriers to technology transfers. One issue is that the transfer of technology is a complex process with many stages and variables. Ambiguities associated with obtaining title to or exclusive license for federally owned patents contribute to limited commercialization. In addition, contractors may be unfamiliar with the technology transferred to them from the government, which creates a hands-off attitude, a "not invented here" syndrome. Significant commercialization costs also may discourage contractors from fully taking advantage of technology transfers.

Schacht (2008) makes two recommendations to improve the chances that technology transfers result in commercial applications: "1) Each program be assigned a government employee to function as a "technology champion" in order to see the project through the complex and time consuming bureaucratic process that accompanies the technology transfer from inception to commercialization. 2) The government switches its orientation from a "technology push," where government owned research is pushed to the commercial market to a "market pull," where the government uses commercial technologies to solve government applications," or requirements (Schacht, 2008, p. 6).

H. CHAPTER SUMMARY

The government and DoD have policy and procedures in place that currently are adequate in sourcing innovations. BAAs broadly blanket the market and advertise federal agencies' needs, especially when the agency is interested in finding commercial solutions to government problems. Answering the government's needs, an organization can suggest various contractual vehicles that best serve all interested parties, such as cost type contract, a fixed contract, a CRADA, or a grant. The most common vehicle is a contract, which incorporates standard federal clauses as dictated by procedure and regulation. However, contracts with small business such as the SBIR and STTR are more flexible than standard contracts but are also subject to procedure and regulation. Grants are even more flexible than simplified acquisition procedures and easier than administrating SBIR

and STTR contracts, but many grants are limited by their scope and how they are used. On the other hand, CRADAs allow the creation of collaborative agreements between the government, universities, and industry partners. A CRADA type of agreement is normally dictated by common business practice. The CRADA spells out the terms and conditions surrounding the limited partnership. However, CRADAs are un-funded. Government funding for research conducted under a CRADA normally comes from a grant.

Crowdsourcing and Open Innovation could succeed by utilizing the policy procedures and regulations surrounding CRADAs. However, to avoid any anti-deficiency and/or antitrust violations, each time a participant logs into the Web site that host the Crowdsourcing event, he or she must accept the terms and conditions that govern CRADAs. Without each participant stating that they are volunteering time and information for free, the government may put itself in a position to have to pay for each participant's time and effort, or pay a royalty to purchase any innovation for which the government funded development.

The next section looks at possible DoD applications of Crowdsourcing to determine its potential as a new method to conduct business.

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VI. VISION OF POTENTIAL APPLICATIONS WITHIN THE DOD

The purpose of this section is to explore possible uses of Crowdsourcing by the DoD, and to determine its potential as an acquisition tool. The first scenario discusses some of the problems the High Mobility Multipurpose Wheeled Vehicle (HMMWV) encountered early in the war with Iraq, and envisions how Crowdsourcing might be used by front-line maintenance teams to communicate with the manufacturer, secondary part manufacturers, the program team, and pre-certified inventors or engineers. The second scenario discusses the Coast Guard's Deepwater Program and Lockheed/Northrop's missed opportunity to work collaboratively with their customer. Crowdsourcing is also a means to connect Web-based video and training, as well as blogs and reference manuals, and bring them to the users of the technology in real time. Crowdsourcing can become a means for user groups to create an online database of organizational knowledge that is continually updated and edited by users with a stake in a particular technology for analysis, decision making and advice.

A. HMMWVS

The High Mobility Multipurpose Wheeled Vehicle (HMMWV) is the U.S. military's main light duty truck. AM General, the manufacturer of the HMMWV, describes it as a diesel-powered, four-wheel-drive vehicle that uses a common 4,400 lb payload chassis (HMMWV-Background, 2009). Originally, it was designed for personnel and light cargo transport behind front lines. During Operation Iraqi Freedom (OIF), the multifunctional HMMWV became the primary transportation vehicle for military personnel in accordance with GlobalSecurity.org (HMMWV, 2009).

According to Global Security (2009), the first HMMWVs to arrive in Iraq had little or no armor protection against direct arms fire. As the insurgency in Iraq grew and patrols came under fire, it became evident to the military that such a lightly armored vehicle did not provide adequate protection for personnel on patrol. As a response to the HMMWV's vulnerability, the military quickly contracted for armor designs and kits to be installed on all HMMWVs destined for patrol duty. The kits included armored doors, side

and rear armor plates and a ballistic windshield plus bullet-resistant glass for greater protection against small arms fire and IEDs (HMMWV, 2009). While the armor kits made the vehicles safer from attack, they also resulted in unintended consequences. The armor plates increased the HMMWV's weight and raised its center of gravity (HMMWV, 2009). The extra weight negatively affected acceleration, handling and braking (HMMWV, 2009). It also overstressed the drive train and suspension, which significantly shortened the vehicle's service cycle. Overall, the armor kit reduced the HMMWV's reliability and service life.

Frontline military personnel and HMMWV mechanics identified the source of the maintenance issues early on. However, it was only with significant delay that this essential piece of information penetrated stateside, since there was no direct line of communication between frontline operations and the stateside HMMWV program team, its engineers and AM General, the HMMWV's manufacturer.

Web 2.0 technologies provide a tremendous opportunity to link geographically dispersed individuals and allow them to communicate about and collaborate on a shared problem. Applying Web 2.0 technologies to the HMMWV's maintenance and handling problems during OIF could have resulted in the following scenario: OIF frontline military personnel and maintenance teams share insights about limitations in handling and steering and increased maintenance needs with stateside program team engineers in real time. Wikis maintain a knowledge database with detailed repair manuals and service bulletins, plus they gather more specific information concerning geography, weather conditions and local infrastructure affecting specific HMMWV repairs. Frontline military and maintenance personnel are given time to edit or critique Wiki Web pages in order to keep all information current and accurate. Helpful how-to video files with hands-on demonstrations can be archived in a Web site similar to YouTube.com and used for reference. The OEMs and component manufacturers use RSS feeds to e-mail service bulletins directly to the individual drivers and mechanics, while they update the Wiki maintenance Web site. The DoD and military services also use RSS feeds to specific target audiences in order to solicit suggestions and gather and disseminate pertinent information to optimize HMMWV maintenance and performance. Geographically

dispersed maintenance teams can post to a maintenance blog and share successes or discuss specific problems maintaining their system.

Applying Web 2.0 technologies also could have resulted in the following scenario: Even before up-armored HMMWVs arrive in Iraq, the OEM releases a service bulletin on the possibility of an increase in required suspension maintenance due to increases in vehicle weight. The OEM's service bulletin is automatically e-mailed to users who signed up to receive them. The OEM posts updates to the suspension system's Wiki Web page and links it to other appropriate sites. The OEM identifies parts that are stressed by the weight-related problem, suggests new maintenance procedures and asks for feedback. The OEM releases a video blog with helpful hints and up-close visual directions. Within their job descriptions, DoD employees, such as product engineers, HMMWV drivers and mechanics, are allowed to set aside time to contribute to blogs offering solutions to others' questions. They do informal market research about similar problems and working solutions in the commercial sector. The Program Team and the OEM monitor these blogs or discussion groups and use data mining tools to sift out possible solutions after they complete their own market research. Using Crowdsourcing concepts and Web 2.0 technologies, program teams can solicit a large group of individuals with pertinent knowledge and expertise to suggest commercial off-the-shelf solutions to existing DoD problems. Recommendations for shortening maintenance cycles and improving turnaround time to keep the vehicles operable can be communicated instantaneously as an interim solution until a permanent solution is found.

Web 2.0 technologies have a broad potential application with the DoD. Sharing of helpful information and "tricks of the trade" as well as instant dissemination of critical information about products and systems has the potential to benefit DoD agencies and all levels of DoD personnel. Such technologies also have potential applications for sharing and passing along strategic and tactical counterinsurgency information about noteworthy dates and locations, details about the local population and geography, as well as best practices and tactics between commanders rotating into and out of the war zone. Web 2.0 technologies also lend themselves to benefit political and military leadership, with

executive staff maintaining Wikis to archive knowledge, official directives, memorandums and policy, thus making them more accessible to pertinent staff.

B. COAST GUARD DEEPWATER PROGRAM

In the 1990s, it became clear that the Coast Guard needed to revitalize its aging fleet because of the increased demands drug smuggling, illegal immigration interdiction and heightened port security put on the fleet (Brown, Potoski & Van Slyke, 2008). At the end of 1998, the Coast Guard released a request for proposal describing their needs and performance goals (Brown, Potoski & Van Slyke, 2008). They called the program "Deepwater." The Coast Guard's Deepwater Program was originally conceived as an effort to modernize the Coast Guard's aging fleet of air and sea vessels as well as the communication interfaces linking them. This program combined the purchases of various physical resources such as patrol boats and cutters, patrol aircraft and helicopters and unmanned aerial vehicles with shore facilities and new command, control and communication devices. The goal was to integrate all Coast Guard assets into one shared communication network (Brown, Potoski & Van Slyke, 2008).

The Coast Guard decided to use an established commercial practice called a lead system integrator to manage the entire modernization program because the Coast Guard lacked sufficient numbers of trained and experienced personnel for the project (Brown, Potoski & Van Slyke, 2008). It was also assumed that a commercial entity would be able to complete the project for less money and on schedule. The Coast Guard ran a limited competition between three large companies and joint ventures with extensive defense industry experience. A combined group from Lockheed/Northrop was finally selected to head the program (Brown, Potoski & Van Slyke, 2008).

Lockheed/Northrop was overly optimistic about their capabilities. The delivery schedule created by the contractor was too ambitious. Because of the program's complexity and the broad range of deliverable major systems, the Lockheed/Northrop team began to fall behind schedule. The contractor did not have the specialized personnel on hand to engineer and fabricate new Coast Guard ships according to specifications. The first delivery of ships failed testing. Other ships were deemed too heavy while still on the

drawing board. The aircraft that were delivered performed to specifications, but the large scale integration of all Coast Guard communication systems posed a tremendous challenge. In their haste to catch up with their schedule, Northrop/Lockheed accepted faulty designs, ignored manufacturing defects and ran over budget. The projected Deepwater budget totaled $25 billion and was spread out over a 25-year time frame. Therefore, the Deepwater program was very visible to Congressional oversight (O'Rourke, 2006). By 2007, with rumors of mismanagement and poor construction emerging, the Coast Guard did not renew their five-year contract with the Lockheed/Northrop Group and instead decided to hire qualified program managers and experienced contracting and engineering personnel in order to run the Deepwater Program under sole Coast Guard oversight.

By incorporating Open Innovation, Web 2.0 technologies and Crowdsourcing, the Lockheed/Northrop Team may have prevented cost overruns, eliminated some long delays and provided superior products manufactured in accordance with the Coast Guard's specifications. For example, Lockheed/Northrop planned on extending the length the 110 ft cutters to create 123 ft patrol boats. However, Lockheed/Northrop approved a design that was structurally weak: during sea trials the hulls buckled and cracked (Mundy, 2007). Early in the design process, Lockheed/Northrop could have conducted a Crowdsourcing event and solicited recommendations from the marine industry, current and retired Coast Guard and Navy personnel, and professional consultants. This search might have found an experienced shipwright or engineer who could have recognized the flaws in their design proposal and suggested an optimal method to accomplish the same modification. In addition, Lockheed/Northrop could have created a joint worker/management blog and asked all employees to collaborate on time saving and cost cutting manufacturing techniques. Employees at Lockheed/Northrop may have identified the patrol boat structural problems if they were motivated to think critically, share their insights, and given a forum for an open discussion among peers before completion of the first patrol boat. Now, Lockheed/Northrop has to absorb the cost of the failed patrol boat conversion and replace the Coast Guard ships at their expense. Ultimately, it is Lockheed/Northrop Team's responsibility to control the cutter's cost. By improving

communication using Web 2.0 technology and openly soliciting ideas surrounding the cutter program, Lockheed/Northrop Team may have identified enough cost saving solutions in order to save the cutter program.

Lockheed/Northrop also ran into trouble designing a new class of ships, the 418 ft National Security Cutter (NSC) featuring an array of modern systems for intercepting ships at sea. Specifically, it has been reported that the NSC is overweight, resulting in a sub-optimal hull design and structural problems that may lead to a shortened life cycle (O'Rourke, 2008**)**. To avoid this design flaw, Lockheed/Northrop might have collaborated closely with European ship designers who have more experience with ships in this size range or class. If Lockheed/Northrop had set-up a Wiki with detailed specifications and other pertinent data on ships similar to each of the Coast Guard's requirements and openly shared relevant and appropriate design information with their European counterparts and other U.S. shipyards, Lockheed/Northrop may have discovered an existing hull design to fill the requirement without footing the expense of R&D.

In developing the Command, Control, Communications and Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) system, Lockheed/Northrop and the Coast Guard missed out on collaborating with the Navy, Army and Air Force who are also working toward developing their own C4ISR systems. The DoD and Homeland Security could have collaborated on shared protocols and procedures, the basic technology, before having each service's contractors build their systems from the ground up. This method of product development is similar to how commercial networks developed wireless protocols such as 802.11 and Bluetooth. Lockheed/Northrop missed an opportunity to work collaboratively with their customer, the Coast Guard, the government Acquisition Team, suppliers, and other shipyards, as well as with other government Agencies' and other outside experts, who may have offered critical solutions that the Lockheed/Northrop Team was unable to conceptualize alone.

C. DOD KNOWLEDGE MANAGEMENT

An online Wiki-style knowledge center, similar to Wikipedia, should be adopted by the DoD to create, store, organize and communicate procedures, regulations, best practices and related knowledge. In addition, this Web site should cross link procedures and regulations to local procedures, legal codes, reports (such as Congressional, GAO, or DoD), presentations and training topics. This Web site needs to be interactive, editable by its users and supervised by a dedicated group of DoD acquisition professionals to control content and cost. The Web site should be accessible by all government employees and the general public. However, classified documents and documents not meant to be viewed by the public should be archived on password-protected Web sites that are only accessible to DoD employees with appropriate clearance. Only, the DoD should benchmark best demonstrated practices of commercial organizations such as Wikipedia by the Wikimedia Foundation, Flicker by Yahoo! Inc and Wikitravel by Creative Commons to bridge this technology gap.

At its most basic stage of implementation, a knowledge center built around Web 2.0, Open Innovation and Crowdsourcing technologies allows greater efficiency in knowledge management by enabling faster access, more efficient search capabilities and more effective cross referencing within the immense libraries of regulations, policies and procedures. Additionally, online technologies such as Twitter allow participants to pose questions and expect near real-time answers to specific acquisition problems from hundreds or thousands of networked acquisition and contracting experts. In addition, Wikis give employees a place to debate changes to FAR regulations and allow for collaborative writing of FAR revisions, while building an up-to-date archive for the DoD's ever increasing amount of online documents.

1. Instituting a DoD Acquisition Knowledge Management System

During the basic stage of implementation, Web 2.0 technologies allow greater efficiency in knowledge management by enabling faster access and more effective cross referencing within the immense libraries of regulations, policies and procedures. Web 2.0 technologies allow near real-time answers to specific questions from hundreds of

networked source experts. As a result, the improved efficiencies found in the search functions of Web 2.0 technologies, such as Wikis, save front line acquisition and contracting personnel time and effort in searching for information. In addition, acquisition policy offices could improve the interpretation and understanding as well as the efficiency of writing new policies and regulations, thereby increasing their usefulness and timeliness. Moreover, using new technology acquisition policy offices can give personnel greater and more timely access to useful information and concomitantly reduce the time, effort and indirect cost of posting new policies.

At an intermediate level, inefficiencies and redundancies can be reduced through interagency collaboration. With Web 2.0 technologies, knowledge about basic research, specific technologies or successful development programs can be shared efficiently between interagency development teams. United on online forums, these interagency development teams can collaborate on a single technology standard, protocol or platform, which can be used across multiple agencies, programs and systems. Therefore, the initial cost of the research is spread out across multiple agencies.

At the most advanced stage, the DoD can use Crowdsourcing techniques to augment the capabilities of acquisition teams by utilizing Web 2.0 Internet technologies such as Wikis, blogs and Twitter to involve a great number of public and private intellects and experts in search of solutions to a research or contracting challenge. Research shows that commercial organizations have successfully used Crowdsourcing techniques to research and source innovative ideas faster, distill them into more practical solutions and implement these solutions into products and services more rapidly. The DoD must consider the efficiencies and thus the cost savings from developing the competencies and skills of acquisition teams when deciding whether or not to use Web 2.0 technologies, Open Innovation and Crowdsourcing for a specific program.

D. CHAPTER SUMMARY

The adoption of Crowdsourcing and Open Innovation practices and the common use of Web 2.0 technologies by the DoD, DoD acquisition teams and DoD contractors could usher in an era of high quality customer service. The warfighter benefits from near

instant delivery of OEM service bulletins, customer managed blog discussions on product maintenance and how-to informational video presentations, command level briefings delivered through podcast and faster communication with multiple colleagues using Web 2.0 technologies. Contractors benefit by spending more time in the development phase creating a better product by incorporating more commercial off-the-shelf solutions into the final product, thereby increasing reliability, lower cost and speeding production. In retrospect, Lockheed/Northrop missed an opportunity to closely collaborate with their customer, the Coast Guard and the government Acquisition Team, suppliers, other shipyards, as well as with other government Agencies and other outside experts who may have offered a solution that was not considered by the Lockheed/Northrop Team.

The next chapter will summarize many of the main ideas and concepts explored in this research project.

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VII. RESEARCH FINDINGS

The purpose of this chapter is to link together the various ideas and concepts introduced in this report. After a brief overview, this chapter opens with the potential benefits that Web 2.0, Open Innovation and Crowdsourcing can bring to DoD Acquisition. Benefits include improving knowledge management by building knowledge centers that organize, edit and communicate procedures and regulations and store knowledge or best practices, potentially saving funds and fostering interagency collaboration on R&D programs. In addition, this chapter introduces some of the limitations of this technology, such as motivating participants, data mining, and security and management buy-in. Lastly, this chapter introduces useful first steps to help integrate Web 2.0, Open Innovation and Crowdsourcing technologies into DoD acquisition.

A. OVERVIEW OF MAJOR INNOVATION CONCEPTS

As previously stated, Open Innovation as a business model requires companies and their management, employees and suppliers, as well as consultants and business networks, to fundamentally change the way they think about sharing information and communicating within their business networks. By utilizing Web 2.0 technologies, companies reach out more efficiently to those in their business networks and efficiently communicate ideas, seek solutions and give advice at a lower cost than a closed business model permits. Organizations who practice Open Innovation also research sources within their network for useful ideas or intellectual property that can improve their core business or product. Additionally, organizations may envision a new product by weaving together intellectual property from more than one source. Moreover, an open business model coupled with Web 2.0 technologies allows a company to successfully market their own intellectual property to other organizations as a source of revenue.

Crowdsourcing as a business practice is an event that organizations use to openly communicate within their business community, to survey potential customers in the earliest phases of product development, or to seek help in developing a product. Organizations running Crowdsourcing events within their business network are asking for

solutions to a specific problem. Solutions can come either from within the organization, such as from another department and/or from an outside source, such as another organization, a consultant, inventor or the end user. Solutions are found either by researching other organizations' intellectual property or by openly soliciting solutions. Solutions can either be "turn-key," where the developer turns over a ready-to-use product, or they can be a series of components and sub-components that the organization assembles into a final product like a jigsaw puzzle. Furthermore, organizations that conduct Crowdsourcing can ask their customers or users to help build, edit, or provide information to improve a product's content.

Companies such as Procter & Gamble, who have successfully adopted the innovative open business model and have integrated Web 2.0 technologies into their business culture, practice Crowdsourcing to lower their costs, broaden their product line and increase revenues. For the government to achieve similar goals, innovators within the government need to consider Open Innovation concepts, Web 2.0 technologies and Crowdsourcing techniques.

B. BENEFITS

Organizations, especially for-profit organizations, that have embraced an Open Innovation business model and adopted Web 2.0 technologies and Crowdsourcing techniques are looking for a competitive edge that will keep them at the forefront of their industry. In order to create a competitive and cutting-edge business environment that expects extraordinary outcomes, the government must also adopt Open Innovation with Web 2.0 technologies and Crowdsourcing as cornerstones in order to attract innovative companies and individuals who offer new concepts with distinctive approaches to business and defense. These collaborative technologies promise to bring more transparency to the acquisition process, which is in line with Presidents Obama's policies.

1. DoD Knowledge Management 2.0

The government can reap benefits from adopting Open Innovation, Web 2.0 and Crowdsourcing by establishing a Wiki-style knowledge database that enables cross

linking of policy orders, laws, memoranda, rules and regulations, standard operating procedures (SOP), forms, as well as best practices and related examples. Currently, each individual category of information is hosted on its own Web site, with some sites offering more comprehensive information than others. However, not a single site offers links to relevant associated information. This makes the search for information complicated and time consuming. For example, searching for the public law and policy memoranda that implemented a change to the Federal Acquisition Regulations (FAR), a government employee must query three separate databases in the hope of piecing together the information into a complete picture. Loading the FAR into a Wiki, however, would allow volunteer users to collaborate, linking regulations to their related laws, policies and memoranda, which would result in a far more efficient way to search for information. (See Chapter VIII Section C, DoD Knowledge Management, for more information.)

2. DoD Open Networks

Commercial organizations utilizing open networks make use of both internal and external networks. Internal networks are built around research personnel and engineers, product teams and marketing personnel. External networks take advantage of integrating specialized knowledge of customers, competitors and university researchers or independent inventors into their organizational structure. Commercial product teams use Wikis to connect with their networks and support creative team environments by allowing collaborative writing and the creation of presentations, archiving documents and building team consensus. Eli Lilly uses a third-party integrator to create and facilitate its open networks, which they then leverage to solve R&D problems and to search for new molecules; Linux, Sun Microsystems and IBM all have created their own open networks of unpaid software developers to help them write software, debug programs and write software updates.

Commercial organizations who adopt an open business model re-structure their policies and corporate culture to take advantage of their networks. Additionally, organizations using open networks also give careful consideration to their product teams as well as their network structures in order to improve organizational performance.

Academic research on group dynamics, previously identified in this report, found that groups with diverse team members, with different experiences and skill sets, facilitate discussions and encourage team members to voice dissenting opinions, resulting in better quality solutions. Proctor and Gamble plan on using its networks to create 50% of its innovations by 2012 and project annual growth of 10 to 15% (P&G, 2009).

In a similar fashion, the DoD needs to exploit its networks to improve research programs and help bring about innovative product designs and system sustainment programs. By adopting commercial open business methods, such as Open Source design and Crowdsourcing techniques, the DoD can speed product development and integrate a higher percentage of commercial products into military systems, resulting in reduced cost and increased user satisfaction. Additionally, open networks give DoD customers a forum in which to become active participants rather than passive spectators throughout the life cycle of their product, which can generate greater customer satisfaction. Therefore, the DoD can achieve similar results with open business models as commercial organizations have by allowing innovative program teams to create networks in order to speed product development, reduce cost and increase end-user satisfaction in DoD programs and systems.

3. Saving Funds

Cost savings constitute another crucial benefit to the government resulting from the implementation of Open Innovation and related e-tools. Savings arise from taking advantage of improved efficiency in searching rules and regulations, as discussed above. However, the greatest cost savings to the government can be realized by introducing a Crowdsourcing event before instituting a contract. Generally, R&D programs are frontloaded with cost because programs pay their prime contractor for spending time brainstorming production techniques, technologies and sourcing components. This part of the development phase can be streamlined with a Crowdsourcing event. In the collaborative environment of a Crowdsourcing event, participants offer unexplored ideas about commercial products and construction techniques that can be integrated into the final product and offer a cost-effective commercially available solution (rather than an

expensive one-of-a-kind approach). Examples of such commercially sourced solutions can include fastening devices that speed up assembly and painting techniques that offer greater resilience. In addition, the companies who decide to compete for the program gain a better understanding of how the government needs the final product to function. This is the case because, in Crowdsourcing, the acquisition timeline is delayed for a longer than normal period, giving contractors and the government program team time to evaluate commercial solutions that either solve the problem or can be modified to solve the problem. Additionally, by scanning blog postings, the government might find several ideas that, when combined, provide a better solution and then ask several contractors to form a partnership and submit a proposal. In addition, the program team can scan blog postings from a Crowdsourcing event to identify potential subcontractors to the project from the list of capabilities posted online.

4. Market Research

The Federal Acquisition Streamlining Act of 1994, section 8305, (FASA, P.L. 103-355), mandated that market research is to be conducted on all requirements over $100K. Market research is an integral, although time consuming, function of the government acquisition process. Market research reduces the risk that a program might fail by determining if commercial off-the-shelf products exist to solve a government requirement or problem. Often, this process requires the time and energy of the contract officer and the government customer, plus a program engineer, price analyst, industrial specialist and small business specialist, among others. However, there is a tradeoff between the value of the requirement and the availability of the acquisition team members: also, there is the time required to evaluate suitable alternatives and current business practices as well as to familiarize the acquisition team with the technology or service. However, with improved contractor participation during a Crowdsourcing events, significant insights can augment market research findings or reduce the need for and the cost of market research conducted by team members. Acquisition team members who regularly participate in Crowdsourcing events with contractors, inventors and entrepreneurs, will have a broader and deeper knowledge of commercially available products and services. Therefore, this

activity can help in lowering some of the up-front costs associated with R&D programs and reduce the pressure for government program teams to rush contracting officers into a less cost-effective noncompetitive contract.

5. Interagency Collaboration

Many government-run acquisition and R&D programs can benefit from interagency collaboration by focusing on common goals and sharing findings. The anticipated benefits of interagency collaboration are funding efficiencies and reduced transaction costs, plus greater product effectiveness, which results in offering products that customers need, when they need them and where they need them. Also, with the DoD supporting increased interagency collaboration, federal agencies benefit from more knowledgeable acquisition teams with greater organizational commitment and teamwork skills. These teams may be better capable of delivering more customer-specific products or services with better reliability and a lower total cost.

Normally, agencies manage their own R&D efforts with the support of their own service or department acquisition teams. Recently, research solicitations seeking detection equipment for chemical and biological agents have been posted by National Aeronautics and Space Agency (NASA), the Center for Disease Control and Prevention (CDC), the National Science Foundation (NSF), Homeland Security and the Department of Defense (DoD). Even though each agency's requirements for research may not be exactly the same, a certain amount of research may be redundant, thus jeopardizing millions of federal dollars. All four agencies could potentially benefit if program teams shared their findings on a common knowledge Web site or Wiki, and team participants cross-communicated through blogs and other Web 2.0 technology.

Federal law allows agencies to jointly fund research programs through the National Cooperative Research Act (NCRA). The DoD and the DoD Military Agencies, for example, share in the funding of the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD), which is responsible for research into chemical, biological, radiological and nuclear (CBRN) defense equipment and medical countermeasures. However, because agencies lack reliable and efficient mechanisms for

quickly sharing research findings, these findings are trapped within agency information silos and are not readily accessible to non-DoD agencies. NASA might benefit from chemical detectors developed for the DoD, as much as Homeland Security might benefit from CDC research into bio-detection. Government agencies need a means to facilitate mass collaboration before they can discover the potential of savings in time and capital and fulfill the meaning of NCRP. Including a large number of agencies could facilitate amortizing the costs of establishing, maintaining and updating a shared knowledge database where research findings of all successful and failed basic research could be data mined by authorized personnel.

Right now, the government allows institutional knowledge to be passed on and to be managed by contractors. After completion of a research project, the current system depends on contractors or experts to continue marketing stored knowledge and technology to the government. Without expertise, however, contractors or experts may forgo patenting and commercialization of their innovation and the research outcome or product may thus be shelved and forgotten. With Web 2.0 technologies, a program team can post research findings and supporting evidence with links to researchers' names and company Web addresses immediately upon the completion of a research project. Any future researcher using such a Wiki Web page for reference could conduct extensive background research and find and communicate with the researchers who conducted the initial research. Research objectives can be honed, designs optimized and costs can be reduced by building upon the previous research findings and expertise of predecessors.

C. LIMITATIONS AND PROBLEMS

As with all technologies, the government will encounter limitations that restrict the use and utility of Open Innovation, Web 2.0 and Crowdsourcing. In *The Wisdom of Crowds* (2004), Surowiecki discusses the limitations of soliciting information from groups of individuals. In order for the government to run successful Crowdsourcing events, the subsequent limitations need to be overcome:

a) Groups need to be diverse and draw on a variety of experience, expertise and specialties to ensure a mix of opinions. Without team diversity, group

decisions suffer from homogenous participants. For instance, if a group includes only male participants who graduated from Princeton University's Woodrow Wilson School of Public and International Affairs within a 5 year time period and all had the same professors, there is a good chance that group members will approach a problem within a similar frame of reference based on a shared group identity, comparable education and formative college experiences. Based on this example, this phenomenon is difficult to monitor without an extensive background and reference check on each contributing individual, especially if the group is brought together over the Internet. The problem is that if a group lacks diversity it is more inclined to draw skewed conclusions due to group homogeneity. In such situations, much time is wasted and money spent in the pursuit of an avoidable flawed solution.

b) Crowdsourcing participants need to remain decentralized from one another and use their own independent research to avoid the "group think" that resulted in the often cited "Bay of Pigs" fiasco. Monitoring and balancing group dynamics remains unchartered territory in Crowdsourcing.

c) Group members need to remain decentralized in order to ensure independent learning and research results and to avoid a "top-down" chain of command approach. Consequently, this effect can be difficult to manage in government agencies, especially the DoD agencies, because their business structure is customarily hierarchical and higher level management use inflexible policies and procedures and multiple layers of management to oversee their span of control. However, decentralized organizations are typically described as having a flatter business structure, thus allowing the program team to be closer to the problem or the product user. As a result, such organizations are more responsive and flexible in problem solving than "top-down" organization.

d) Motivating group members to research and solve a small piece of the puzzle within their area of expertise, contribute their findings toward a

comprehensive solution, or collaborate within the collective may constitute a tremendous challenge in some organizations and to some individuals. An organization may say that it wishes to practice Open Innovation and Crowdsourcing, but the internal culture of the organization is suspicious of innovations not created within their own company. When an organization institutes Open Innovation and Crowdsourcing practices, they need to proceed incrementally and have teams collaborate on projects that can easily be completed successfully. The organization needs to consider both intrinsic and extrinsic rewards such as letting people volunteer for projects they have an interest in, allowing 2 to 4 hours per week to explore using the new technology and having employees share their successes as well as their failures. Also, organizations can offer financial incentives, such as time off, contests that reward the best idea and/or a financial stake in a new innovation. (Minshall, Mortara, Napp & Slacik and, 2009)

e) Reliable mathematical or statistical processes must exist to compile and analyze the individual solutions and aggregate them into an average of averages in order to determine the optimal collective solution. In his book, Surowiecki (2004) glosses over the best processes to mine and aggregate data into a solution. Information can be gleamed from surveys stored in relational databases, but information can also be stored on the Internet, or on massive networks which requires specialized knowledge in search methodology called meta-analysis that combs through published data looking for patterns depending on search constraints.

f) Surowiecki's (2005) research supports that diversity, independence, decentralization and proper aggregation encourages independent learning and research as well as specialization of individuals. His research confirms that large groups or "crowds" of motivated individuals, with everyone working independently on the same problem, will likely arrive at the best aggregate solution. Therefore, proper selection of participants for

government Crowdsourcing events must be a top priority, since final findings can be severely biased if too many participants share similar views and opinions or come from similar educational backgrounds or specialties. Further, research is thus needed to determine how a selection committee can determine the most effective mix of participants to ensure an unbiased solution.

1. Limitations of Group Behavior

DoD weapon systems and programs are managed by acquisition teams and, therefore, suffer from the same problems with group behavior as any commercial organization. The same facts about group behavior and team dynamics hold true for Internet-based virtual teams conducting an online Crowdsourcing event, as for teams assembled in the same room. This report maintains that without properly selecting and recruiting specific participants and managing group participation, group solutions and outcomes can be biased by homogeneity or group think, by an overly assertive individual swaying the opinion of an apathetic group, as well as by group polarization and group apathy. The solution to these potential problems is recruiting diverse individuals, from experts to generalists, who exhibit a wide range of opinions. It is essential to ensure independence of these individuals from each other to dissuade peer influence and maintain their decentralization so that participants utilize their personal knowledge and research when formulating an opinion. Thus, the ensuing debate over a solution is enhanced by people's prior experience and knowledge, a greater range of information and unique perspectives.

In addition, all teams face a common problem when making a final decision. Therefore, a Crowdsourcing event is not unique or different from other group decisions. The acquisition team must devise an accurate means of aggregating the team's opinions into a collective decision.

However, acquisition agencies using Crowdsourcing and Web 2.0 technologies can decentralize organizational power and involve the employees closest to a problem in finding a practical solution. This inclusive approach motivates local management and

employees to explore more efficient solutions and accept greater responsibility. Greater participation is encouraged by re-structuring incentives to reward implementation of ideas and knowledge. Furthermore, in the virtual environment of the Internet (i.e., during a Crowdsourcing event), team members and participants feel freer to voice dissenting opinions and brainstorm radical unconventional ideas. The ability for acquisition team members to interact and function cohesively is critical to improving an acquisition team's efficiency and effectiveness in maintaining and bringing better products to the warfighter.

2. Acceptance of New Technology

The implementation of Web 2.0, Open Innovation and Crowdsourcing by the DoD will meet at least some resistance from the acquisition workforce because it poses a fundamental cultural shift from the current closed business model that the government has been practicing and the staff has grown accustomed to. The technology acceptance model suggests that a number of factors determine people's acceptance of a new technology, such as acceptance of the technology within the general public, personal feelings about new technology in general, personal motivation to use a new technology over current technology, social influences and behaviors, etc. However, two factors stand out as key constraints. The first factor is ease of use of the technology and the second is its perceived usefulness. The DoD must take these two factors into account when designing the Web 2.0 interface. If future DoD Wiki style Web sites are not intuitive for users to understand, maneuver and locate information, then the designers risk their acceptance in the general DoD community and, therefore, their benefits may never be realized.

Acquisition agencies and upper-level management should understand that their program teams may initially wish not to accept this technology. In this event, management needs to be ready to counter resistance with information, training and test runs in order to raise awareness about the usefulness of this new technology.

3. Motivating Participants

When selecting participants for a Crowdsourcing event, their natural limitations must be considered. Web-based groups, just like any other group, can suffer from dysfunction. Surowiecki (2004) discusses some key problems of teamwork environments, such as group participants who know each other and have similar backgrounds may imitate one another and limit their capacity to act truly independently. This behavior was reported by Surowiecki (2004), who states that imitation of peers appears in organizations that are risk averse. For example, in a recent study conducted in the Netherlands, the authors found that people who are attracted to work in the public sector are highly risk averse (Buurman, Dur & Van den Bossche, 2009). Therefore, one can conclude that people who work for the government will imitate one another and seek information on a subject from the same source, limiting independence in the decision making. For that reason, employees in any organization who act with limited independence may form opinions and come to conclusions that are very similar to their colleagues', thus appearing to reach consensus. However, their decision is not based on rational analysis of information. Rather, people choose the solution with the least resistance so they can return to work they consider more important, which is known as "herding." They may also form opinions and solutions based on referencing the same information and not paying attention to available diverse information, called "*information cascades*." Therefore, groups that lack proper independence end up with skewed results by referencing faulty or biased information, an undesirable potential outcome of DoD Crowdsourcing.

Surowiecki (2004) states that only independent learning and decentralization encourages and motivates individuals to collaborate on projects and cooperate in groups in order to solve difficult problems. He further theorizes that, once individuals participate in a high-profile project and are exposed to a large number of participants who are driven to succeed because they know their findings will make a difference and fuel an important change, individuals motivate each other and their drive to find a practical solution becomes self sustaining. Additionally, the expectation of future financial rewards can play an important role in motivating contractors, consultants and inventors.

In *The Wisdom of Crowds*, Surowiecki (2004) does not determine the factors that motivate, initiate or bring together a diverse crowd of people and encourage them to form a group that identifies with one another as a community or team. In addition, Surowiecki (2004) does not discuss how crowds or teams keep performing after the crowd recognizes itself as a community. Luckily, research on group development and group performance has been the subject of study since the early 1900s, and a broad range of group dynamics has been identified and defined. Common topics in the formation of groups include group and team size, patterns of how groups self-organize (hierarchy vs. flat) and the association of group members and their relationship to one another. Group performance has also been examined to determine how frequently members should meet, how to achieve a quality output, how much interest group member take in the group's formation or group cohesiveness and how to resolve conflict.

a. Group Development

The basic elements of group development have been described by Bruce Tuckman, a psychologist who researched the theory of group dynamics, in his article, "Developmental Sequence in Small Groups" (1965). In his article, he first describes the founding principles that are now known as the Tuckman's Stages Model and more familiarly known as "Forming, Storming, Norming, Performing." Tuckman (1965) argues that every group will pass through each one of these phases before they reach a solution. Tuckman defines each phases:

- Forming is when individuals in the group or team get to know one another, get along or at least pretend to get along.
- Storming is when civility breaks down in the group as issues are identified and prioritized and conflict replaces politeness.
- Norming takes place after group members become used to each other's personality, and trust is built after the group experiences productivity.
- Performing is when the group enters a highly productive phase characterized by common goals, efficiency and cooperation.

Tuckman believes by understanding the dynamics of the four stages, leaders can help groups move more quickly through each stage to become a high performing team faster. This motivates team members to maintain interest in the group, be more cooperative and collaborative within the group and contribute useful information leading to more effective output. Therefore, the process becomes the motivating factor that leads to a high performing team. The Tuckman's Stages Model has become the basis for succeeding models.

However, as important as the Tuckman's Stages Model has been, it is very difficult to link Tuckman's theory to Open Innovation and Crowdsourcing. This is because Open Innovation and Crowdsourcing depend on using the Internet as a communication tool to bring together remote and dissociated individuals in order to form a group into an online community with the expectation of creating highly effective solutions and useful output.

In his book, *The Different Drum: Community Making and Peace* (1987), Dr. Morgan Scott Peck, a former Army lieutenant colonel, assistant chief psychiatrist and neurology consultant to the U.S. Army Surgeon General, builds on Tuckman's Stages Model in describing what a community is, the stages of community building and how diverse groups get past their differences. Peck (1987) sees the ability to build communities as an important process that leads group members to deeper, more authentic communication. Peck (1987) suggests that authentic communication provides a safe place where people are motivated to work collaboratively on common goals. As mentioned in each of the discussed books in the literature review of this report, it is the sense of community that drives participants to contribute and produce high-quality work.

b. Contribution and Cooperation

Peter Kollock (1999), associate professor of sociology and vice chair in the department of sociology at the University of California, focused his research on the idea that exchange in online communities is the motivating factor behind contribution and cooperation, and maintains that cooperation can be perpetuated by earning credits and a relatively loose accounting system. In *The Economies of Online Cooperation: Gifts and*

Public Goods in Cyberspace (1999), Kollock describes three reasons why group members or users in an online community contribute:

(1) *Anticipated reciprocity*, which states that a user is motivated to contribute to the community in the expectation that he will receive useful help and information in return;

(2) *Increased recognition*, where individuals want recognition for their contributions, thus, the desire for prestige is one of the key motivational factors for an individual's contribution to an online community.

(3) A *sense of efficacy*, where individuals contribute because of the sense that they have had some effect on the community. Wikipedia is an example of this effect. (Kollock, 1999, pp. 220–239)

In addition, Kollak (1999) finds that contributions will increase if they are visible to the entire community and are credited to the contributor. Also, he states that the powerful effects of seemingly trivial markers of recognition such as stars or rankings are irresistible to some individuals. However, even Kollock recognizes the limitations of his research and strongly suggests that further research be conducted in identifying the exact motivational factors that lead people to contribute to online communities and to see if other incentives can be identified that can inspire even greater participation.

In his doctorial thesis dated August 2009, Daren Brabham interviewed 17 participants from Threadless (http://www.threadless.com/), a company whose Web site utilizes Crowdsourcing to design and sell T-shirts. On Threadless.com users submit T-shirt designs, get to vote for the best designs, try to win a graphic design award for their T-shirt, blog about their designs and buy them. In "Moving the Crowd At Threadless: Motivations for Participation In a Crowdsourcing Application" (2009), Brabham describes four motivating factors that Threadless participants state as reasons for contributing to the Web site:

- Earning money
- Developing creative skills;
- Picking up freelance work; and
- Enjoying the sense of community.

In addition, one individual describes making contributions to the Web site as "addictive." Brabham (2009) found that participants to iStockphoto also identified the first four factors as motivation for their contributions, which verifies the results of an earlier 2007 study conducted by InnoCentive, a company mentioned earlier in the report. However, Brabham (2009) identifies a 2007 study where individuals collaboratively writing a feature-length sci-fi parody of *Star Trek* called *Star Wreck,* expressed no interest in earning money from their contributions. Therefore, Brabham (2009) concludes that there are no consistent factors that motivate people to participate in any Crowdsourcing event. However, research shows that people can be motivated by financial rewards, developing skills they value, becoming a freelance consultant or technician and gaining a sense of contributing to a larger community for recognition.

c. Undermining the Concept of Collaboration and Trust

Anecdotal evidence shows many people contribute daily to social networking Web sites, blogs and participate in Crowdsourcing events with no obvious financial benefits. In fact, Steve Cook (2008) states in the *Harvard Business Review* that financial incentives for contributions may undermine the concept of collaboration and trust. Cook states that participants may simply enjoy making a contribution or may not even be aware of the value of their contribution. Additionally, Cook (2008) states that participants may be intrinsically motivated to contribute by a feeling of altruism, by a sense of belonging to a larger community, by their desire to express themselves in front of a large audience or by their drive to gain a reputation as a knowledge expert or leader in their field. Contractors can be motivated to participate in forums that allow them to broadcast their company's technology and to promote their capabilities and strategies for improving future programs because this behavior can result in valuable exposure within their marketplace and translate into future business. This also allows individuals the opportunity to network professionally in anticipation of finding more interesting and financially lucrative work. However, contractors may also decide to hold back important information in order to maintain a competitive edge during the ensuing solicitation period prior to submitting a proposal. Therefore, the government must conduct further research

into the drivers of motivation to ensure, on the one hand, sustained participation of relevant government and non-government participants in Crowdsourcing events, Wikis, blog processes and on the other hand, to encourage complete disclosure and discourage the withholding of pertinent information.

d. Motivating Government Employees

This project recommends a variety of techniques to motivate government employees to participate in Crowdsourcing events and on social networking Web sites:

- Bonuses, awards and contests offering financial incentives;
- Awarding a certain number of continuous learning points (CLP) for specific Web-based activities;
- Allowing employees several hours a week to participate in a government Crowdsourcing or social networks on subjects they have an interest in. This is a strategy used by Google with its employees;
- Making minimal contributions from each employee mandatory in order to avoid a self-selection bias and to ensure inclusion of all relevant employees.

This can take a format similar to an online school discussion board, with employees being required to participate and post comments relevant to a particular subject matter two or three times per week, for example. However, this may contribute to poor input. As part of their job description, government employees with special knowledge can be asked to contribute or participate in Web-based activities, such as editing Wiki pages, contributing to a blog or participating in Crowdsourcing events, much in the same way people are asked to participate or volunteer in a meeting. Therefore, it is recommended that the government develop policy and guidelines for federal agencies to create incentives and put them into action.

4. Data Mining for Useful Information

Online data is collected in one of two ways, either through a passive system or through an active system. A passive system collects data without direct user involvement. Passive systems depend on software programs that pick up specific bits of user data and the software reassembles data into useful information without the direct human

involvement and often without the knowledge and explicit consent of the user. A popular consumer application is smart phones that come with a GPS chip and allow for tracking the location of friends (other users) on the network in real time. In an active system, data is collected from information that has been created with direct user involvement. A commercial example would be retail Web sites that save shopping preferences, payment methods and delivery information input by users; another example is blogs that save comments and discussion strings also input by users; additionally social networking Web sites such as MySpace save entire interactive user profiles that are generated by the user. This data is saved by both passive and active systems on Web sites or databases can be mined and analyzed statistically to find trends and predict potential future scenarios.

Passive and active systems create a tremendous amount of data that is stored on server farms and on main frame computers. The total volumes of data in commercial systems are estimated to be doubling every three years. The ability to transform this data into practical knowledge and actionable strategies is becoming a key objective for researchers and businesses. This is the real purpose of data mining. Data mining is a series of statistical methods that look for patterns or answers to specific questions and is a common practice across organizations and industries. Commercial organizations successfully leverage data mining, for example in marketing; to identify trends and customer segments; and in financial institutions for surveillance and fraud detection.

Data mining is connected to Web 2.0 because Web 2.0 technologies generate an overwhelming amount of information, data points, opinions, theories and a plethora of useless comments. Therefore, these technologies are useful to Web site managers who are either policing the quality of data or are mining millions of bits of information for nuggets of genius or inspiration. Today, many software systems, both commercial and freeware, support Web 2.0 environments. As indicated before, efficiently sifting through the huge amount information generated within the Web 2.0 environment remains a paramount challenge. Currently, statistical software provides the only means of accomplishing this feat. In order to use statistical software, all inputs have to be identified, categorized and input into a database for further analysis. Crowdsourcing can be utilized as a means to input data into databases by either paying people pennies for

each bit of information or creating a game out of the input process. Crowdsourcing can also be used as a vehicle to create a specific algorithm or an optimal database structure to sift through data and identify and analyze information more efficiently and effectively. Additionally, organizations may allow open access to a dataset and invite amateurs, individual analysts or teams to identify and extract relevant information and win a financial or other award in the process. Further study is needed to determine if software can be enhanced to sift through online information sources such as blogs, Crowdsourcing replies, e-mails, Twitter "tweets," etc., to reliably create and analyze databases without human intervention.

5. Security

Security is an important concern for two reasons: Classified information must never be viewed by employees who do not have the appropriate security clearance, and industrial as well as foreign espionage must be prevented. Therefore, each system or program needs to be classified based on its security level, its uniqueness and its potential for commercial exploitation. The level of security depends on the age of a system or program and its projected lifecycle, along with the amount of information already in the public domain. Set security procedures and regulations must be instituted and enforced. However, if these procedures and regulations are too restrictive, they jeopardize the ability to gather a large enough number of participants to reach critical mass for solving complex problems. For sensitive systems or programs, the government can restrict participants, including government employees and contractors, to individuals who come pre-vetted with certain levels of security clearance.

Spillover poses another security threat. Spillover happens when classified information moves from a secured Web site to an unsecured Web page or into an e-mail sent to inappropriate recipients. Frequent mandatory training about online security for all participants and qualified editors can enhance the security of classified information. Routines to automatically restrict the dissemination of classified information can also be embedded in the Web 2.0 environment. These embedded routines automatically preclude secure information from being copied into e-mails, saved in remote locations, printed and

so on. Any such attempt results in the immediate abortion of the application and activity and in an error report to the user and the relevant security personnel.

Moving from a closed business model to an open business model, the DoD is at risk for security breaches, or classified information being released on a Web site that is accessible to the public. The greater the number of individuals participating on a program, the greater the concern about potential security breaches. Regulations and procedures must be implemented by the DoD acquisition community taking into consideration the current age of the system or program, its projected lifecycle, its uniqueness or the exclusivity of its technology and its potential for commercial exploitation. The bottom line is: Not every system or program lends itself to an open business model and careful consideration must be given to the impact of possible security breaches that risk our national security. However, the DoD should make the assumption that all systems and programs adopt an open business model and, only after careful review by the acquisition team, allow firewalls to be built around classified information. Currently, document management software is available that only allows those with the proper clearance to open and save a document. Therefore, commercial solutions are available to protect pertinent information.

6. Upper Level Management Buy-In

For the government to adopt Open Innovation, Web 2.0 technologies and Crowdsourcing, a long-term commitment in the form of funding and upper management support is imperative. Setting up the necessary legal framework of regulations and procedures takes time. This delay allows a program office to put the infrastructure in place, such as: select software, determine if the hardware will be leased or purchased and select and hire a contractor to set-up a turn-key system. These activities require a long-term commitment of funds that remains secure for a sufficiently long trial period.

Further studies must be conducted to determine the correct level of funding and establish appropriate milestones that take the pilot project to full scale acceptance. President Obama is Internet savvy and in favor of using Internet technologies to do business better, faster and with greater efficiency. On January 21, 2009 a Presidential

Memorandum was issued on the subject of Transparency and Open Government, stating that the government should be transparent, participatory and collaborative. Executive departments and agencies should use innovative tools, methods and systems to communicate and cooperate with each other and across all levels of government as well as with nonprofit organizations, businesses and individuals in the private sector. President Obama was speaking specifically about using the Internet to improve the business of government. The recent creation of the position of Chief Technology Officer by President Obama speaks volumes about where he intends to take the government and the Nation. However, significant problems and friction can arise, within the government as in any large organization, when a monumental technological and cultural shift is expected within a conservative low tech culture.

7. Accelerating the Dissemination of Innovation and Knowledge

This report identifies the Bayh-Dole Act as a root cause of the ebbing flow of dissemination of knowledge and innovation. The passage of the Bayh-Dole Act allows top universities and non-profit organizations to hoard their inventions and leverage their intellectual property with patents to reap financial benefits. However, these actions have negatively influenced R&D by preventing early peer review, by keeping non-patented research from publication and by preventing other researchers from utilizing non-peer reviewed research as a basis for spin-off technologies. In consequence, in recent years, the rate of innovations released by large corporations has been decelerating and the time to introduce an innovation to the commercial market has increased. As the modern battlefield has become more asymmetrical in recent years, as witnessed in Iraq and Afghanistan, innovation has to move ever more quickly from the research laboratory to the warfighter.

This report suggests the adoption of Open Innovation, Crowdsourcing concepts and Open Source licensing in combination with Web 2.0 technologies, can defuse the impact of the Bayh-Dole Act by accelerating the dissemination of innovation and knowledge. Acquisition teams can minimize the redundancies in basic and applied research by allowing joint programs across multiple agencies. For example, DoD, NASA,

Homeland Security and the CDC are all interested in biological and chemical (bio-chem) detection, but for different reasons. With the new technologies and business practices discussed in this report, data, findings and technology from basic and applied research can be jointly funded by multiple bio-chem acquisition teams, disseminated via the Internet, and be accessed electronically in real time by all relevant personnel through an online commons. Then, acquisition teams could determine practical solutions or further refine a particular technology during Crowdsourcing events with contractors and researchers. Further, increasing the visibility of government programs across government agencies improves the chance of acquisition teams recognizing viable commercial solutions or products that can be integrated into their systems. This has the potential to speed up the development cycle and lower costs at the same time.

In addition, the government can increase the potential for commercial spin-off technologies by raising public awareness of government owned innovations, knowledge and intellectual property by publishing them on Web sites. Inventors and private researchers could search for innovations, ask questions, network with each other and share ideas on blogs and Wikis about integrating new technology into commercial products. Consequently, greater transparency of non-classified government research may serve as a catalyst for exploitation in the commercial market and as a spring board for future new markets and economic growth in general.

Finally, the government should incentivize private and public organizations to conduct R&D in targeted industries by allowing them to retain the right to use or own patents created during the performance of a government contract. However, the government retains the rights of patents developed in government laboratories, and neither markets, sells nor leases its intellectual property (IP). Thus, government owned patents, in general, are not commercialized. However, for-profit organizations, such as Proctor and Gamble and DuPont, have discovered that their unused IP and patents have value and can provide a new stream of revenue. Crowdsourcing can increase awareness of government owned IP in the for-profit sector of the economy. The federal government can accelerate commercialization of its IP by making it available either for a fee or even at no cost as a low cost economic stimulus. Contractors, who successfully integrate

government IP into a new technology and develop a new commercial product, benefit the economy by creating new markets and/or expanding existing markets, potentially creating new jobs and increasing tax revenues as an indirect consequence of Crowdsourcing.

D. SOLUTIONS

1. Benchmarking Successful Commercial Programs

In order to successfully implement Open Innovation, Web 2.0 and Crowdsourcing, the government needs to put together a diverse team of government experts as well as political and business representatives, to staff a steering committee.

Together they would agree on a vision statement, create a mission statement and devise a strategic plan outlining desired outcomes, to support the strategic plan. For the steering committee to demonstrate its belief in this new technology, the vehicle for this process should be a Crowdsourcing event. The steering committee also needs to fund and conduct the aforementioned studies and benchmark successful commercial programs and, in particular, Web-based innovation integrators such as InnoCentive.com, Yetz.com, Nine Sigma and Your Encore. Concomitantly, it is important for the steering committee to establish task forces to investigate legal issues such as intellectual property, Open Source copyrights, as well as policy, regulations and rules in order to issue executive orders and directives to the Department of Defense.

2. Starting Small When Implementing Web 2.0 Tools

To jumpstart the open sharing of information, the steering committee can implement a Wiki-style Web site to archive and share the large collection of information contained in the FAR and DFAR, government policy papers, memoranda, best practices, GAO Reports and Finding, Congressional Reports and DAU training. Considering that all of these pages and reports already exist in compatible digital formats, editors are only needed in the beginning to link these items in a logical fashion. Over time, as trained government employees become more and more familiar with interactive databases for

routine purposes, they can contribute, collaborate, input, and edit links on these Wiki WebPages. With Wiki technology, a contract officer can locate a specific FAR clause and on the same page find, add, and edit links to related DFAR clauses and to the regulations instituting that clause, the policy memo directing any uses of that clause, GAO and Congressional Reports, videos discussing the subject, and related DAU training. Currently, each type of these government documents is hosted in a separate database. These databases can be accessed from the same Web site. However, after finding a specific FAR within its designated database, a contract officer has to leave this database and access a different database that is exclusively devoted to the DFAR. The same holds true for the GAO Reports and Findings, etc. Searching these disconnected databases takes time and causes the same searches for the same related documents to be performed over and over again by different contract officers. In a Wiki environment, after a contract officer performs the first search and links different government documents with related topics, the next contract officer researching the same topic can benefit from the links added by the colleague mining the database just prior. This allows each contract officer to benefit from their collective expertise and boost organizational learning, knowledge and memory. As more employees become comfortable with Wiki technology and continue to add links within the Wiki, this interactive database becomes more and more efficient and accurate.

The steering committee can also institute a Twitter account for acquisition professionals, where users can post a short question, communicate it instantaneously to the entire electronically linked acquisition community and any acquisition professionals can respond with an appropriate FAR regulation or clause and send a Web page link to a Web page with the answer. The implementation of a DoD Acquisition Wiki and a DoD Acquisition Twitter account is a simple and low cost application that not only facilitates a more open government but also helps acquisition professionals simplify time consuming searches for critical regulations and policies. Since these applications have become very user friendly and the general public has already embraced them, many acquisition professionals may already be familiar with these technologies so that training needs will be minimal.

3. Testing Crowdsourcing with Market Participants

To test Crowdsourcing with participants outside of the government, small commercial programs need to be identified that can host a Crowdsourcing event without exposing any classified information. Considering that successful software projects were Crowdsourced and contain Open Source copyrights, the best example being Linux, a software project can be an initial choice for a pilot. As the pilot progresses, organizational learning from successes and failures have to be carefully documented and evaluated to optimize the technology, update the legal framework and infrastructure and establish its utility to the government. Over time, as Crowdsourcing becomes a standard practice, each program can have its own Web site containing program highlights, a blog, videos, Twitter accounts, training, etc. Information about each program, such as milestones, cost expenditures, schedules and others, could be continuously updated and accessible to relevant personnel.

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VIII. RECOMMENDATIONS

This research recommends that the DoD evaluate and support emerging Web-based technologies, and new methodologies with a proven track record in commercial and non-profit organizations, to jointly perform R&D and develop new and better products faster in collaboration with their customers so that the military is equipped with better products, systems and services than the enemy they face. The analysis contained in this report supports the following recommendations:

1. Due to the complexity of federal acquisition regulations, acquisition and contracting professionals require an Internet-based Web site to reference a database of acquisition knowledge. This database needs to allow acquisition professionals to search federal acquisition regulations and procedures, major directives, memos, legal cases and best practices (including examples) all cross referenced and hyperlinked for reference. The database should benchmark Wikipedia and similar Wiki-style online knowledge database applications as a baseline for ease of use and efficiency, identify the key factors contributing to its success, and investigate any shortcomings and potential causes of future failure. The final result is to create a database that will bring together critical acquisition information across numerous federal agencies, DoD, and finally all other federal agencies that is maintained and edited by users, similar to Wikipedia.
2. Conduct a cost-benefit analysis to determine if long-term savings through increases in efficiency using better knowledge management and interagency collaboration outweigh short-term expenditures for setting up the technological infrastructure and legal framework. A trial open acquisition program should be developed and its effect on long-term cost savings examined. For example, Open Office suite of software, shareware available at no cost, or similar word processing, spreadsheets, and presentation applications should replace Microsoft's Office applications on desktop and laptop computers. This project can be released for use on an agency by agency basis with the final product

used across the all federal government agencies. Federal government software developers, freed from maintaining Microsoft products, can join independent developers online in an open forum to continuously upgrade and improve each of the applications. The acquisition team should conduct a cost-benefit analysis to determine the savings, any increases in efficiency, and the usefulness of Open Source software, if any, to the federal government by replacing Microsoft applications with shareware.

3. Research security concerns and possible solutions to prevent classified information from spilling over to inappropriate personnel and unclassified Web sites. Extend current DoD security clearances and hierarchy of users to viewing a document.
4. Explore the legal framework and implications behind the use of Crowdsourcing in terms of competition, compensation and collaboration (as identified in the report). Extend current DoD security clearances and hierarchy of users viewing a document.
5. Conduct research into motivation of volunteer, commercial, and government participants to Wikis, blogs and Crowdsourcing events. A survey is an initial low-cost approach to determine in particular government workers' feelings, attitudes and knowledge of these online events. A survey will give an indication of how smooth or difficult a transition from the current databases to a Wiki-based database will be. If the survey detects biases, inconsistencies or concerns with the transition that coincide with certain demographic features, focus groups of specific groups need to be conducted to gain further insights into drivers of and obstacles to motivation.
6. Conduct research to determine how a selection committee can determine the most effective mix of participants (DoD acquisition professionals such as program engineers and managers, legal personnel and contracting officers, contractors, academic experts conducting basic research and users) to ensure a statistically significant and unbiased solution from the Crowdsourcing process.

APPENDIX. GLOSSARY OF TERMS

(This glossary is driven by Wikipedia.com)

Blog	Contraction of the term ***weblog***, is a type of Web site, usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video.
Crowdsourcing	Neologism for the act of taking a task traditionally performed by an employee or contractor, and outsourcing it to an undefined, generally large group of people or community in the form of an open call.
Email	Method of exchanging digital messages, designed primarily for human use.
Ethernet	Family of frame-based computer networking technologies for local area networks (LANs).
Facebook	Free-access social networking Web site that is operated and privately owned by Facebook, Inc.[1] Users can join networks organized by city, workplace, school, and region to connect and interact with other people. People can also add friends and send them messages, and update their personal profiles to notify friends about themselves. (www.Facebook.com)
Firefox	Free web browser descended from the Mozilla Application Suite and managed by Mozilla Corporation.
Instant messaging	Form of real-time communication between two or more people based on typed text. The text is conveyed via devices connected over a network such as the Internet.
Internet forum	Online discussion site.[1] It is the modern equivalent of a traditional bulletin board, and a technological evolution of the dialup bulletin board system.[2][3] From a technological standpoint, *forums*[note 1] or *boards* are web applications managing user-generated content.[4][5]
Keiretsu	Set of companies with interlocking business relationships and shareholdings. It is a type of business group.

Linux	Generic term referring to Unix-like computer operating systems based on the Linux kernel. Their development is one of the most prominent examples of free and open source software collaboration; typically all the underlying source code can be used, freely modified, and redistributed by anyone under the terms of the GNU GPL[5] and other free licenses.
Marketocracy	A Web site made available to the public at that time permitting any user to manage a number of virtual mutual funds with $1 million of virtual cash available to invest. (www.Marketocracy.com)
Message board	Online discussion site.[1] It is the modern equivalent of a traditional bulletin board, and a technological evolution of the dialup bulletin board system.[2][3] From a technological standpoint, *forums*[note 1] or *boards* are web applications managing user-generated content.[4][5]
Music-sharing	Practice of distributing or providing access to digitally stored information, such as computer programs, multi-media (audio, video), documents, or electronic books. It may be implemented in a variety of storage, transmission, and distribution models.
MySpace	Social networking Web site with an interactive, user-submitted network of friends, personal profiles, blogs, groups, photos, music, and videos for teenagers and adults internationally. (www.MySpace.com)
Napster	Online file sharing service, predominantly used to share MP3 music files.
Picture Sharing	Publishing or transfer of a user's digital photos online, thus enabling the user to share them with others (whether publicly or privately)
Pod cast	Series of digital media files, usually digital, audio, or video, that is made available for download via web syndication. The syndication aspect of the delivery is what differentiates podcasts from other files that are accessed by simply downloading or by streaming: it means that special client software applications known as *podcatchers* (such as Apple Inc.'s iTunes or Nullsoft's Winamp) can automatically identify and retrieve new files when they are made available, by accessing a centrally-maintained web feed that lists all files associated with a particular podcast. The files thus automatically downloaded are then stored locally on the user's computer or other device, for offline use.

Second Life®	Virtual world developed by Linden Lab that launched on June 23, 2003 and is accessible via the Internet. A free client program called the Second Life Viewer enables its users, called Residents, to interact with each other through avatars. Residents can explore, meet other residents, socialize, participate in individual and group activities, and create and trade virtual property and services with one another, or travel throughout the world, which residents refer to as the grid. (www.SecondLife.com)
Social Media	Content created by people using highly accessible and scalable publishing technologies. At its most basic sense, social media is a shift in how people discover, read and share news, information and content.
Social-Network Services	Focuses on building online communities of people who share interests and/or activities, or who are interested in exploring the interests and activities of others. Most social network services are web based and provide a variety of ways for users to interact, such as e-mail and instant messaging services.
Twitter	Free social networking and micro-blogging service that enables its users to send and read other users' updates known as *tweets*. Tweets are text-based posts of up to 140 characters in length which are displayed on the user's profile page and delivered to other users who have subscribed to them.
Vlog	Form of blogging for which the medium is video.[6] Entries are made regularly and often combine embedded video or a video link with supporting text, images, and other metadata.
Voice over IP	general term for a family of transmission technologies for delivery of voice communications over IP networks such as the Internet or other packet-switched networks.
Web 2.0	Refers to what was perceived as a second generation of web development and web design. It is characterised as facilitating communication, information sharing, interoperability, and collaboration on the World Wide Web. It has led to the development and evolution of web-based communities, hosted services, and web applications. Examples include social-networking sites, video-sharing sites, Wikis, blogs and folksonomies.
Weblog	Type of Web site, usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video. (See “blog)

Wiki	Web site that uses Wiki software, allowing the easy creation and editing of any number of interlinked (often databased) Web pages, using a simplified markup language.[1][2]
Wikipedia	Free,[5] multilingual encyclopedia project supported by the non-profit Wikimedia Foundation. Wikipedia's 13 million articles (2.9 million in the English Wikipedia) have been written collaboratively by volunteers around the world, and almost all of its articles can be edited by anyone who can access the Wikipedia Web site.[6] (www.Wikipedia.org)
YouTube	YouTube is a video sharing Web site on which users can upload and share video clips, and view them in the MPEG-4 format. (www.YouTube.com)

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